

THE NAUTILUS

THE PILSBRY QUARTERLY
DEVOTED TO THE INTERESTS
OF CONCHOLOGISTS



VOL. 83

JULY, 1969 to APRIL, 1970

EDITORS AND PUBLISHERS

R. TUCKER ABBOTT

Delaware Museum of Natural History, Greenville, Delaware

HORACE BURRINGTON BAKER

Professor Emeritus of Zoology, University of Pennsylvania

CHARLES B. WURTZ

La Salle College, Philadelphia, Pa. 19141

MRS. HORACE B. BAKER

11 CHELTEN ROAD

HAVERTOWN, PENNSYLVANIA 19083

THE NAUTILUS

Vol. 83

July, 1969

No. 1

DONAX FOSSOR: A SUMMER RANGE EXTENSION OF DONAX VARIABILIS¹

By PAUL CHANLEY²

Virginia Institute of Marine Science, Gloucester Point, Virginia 23062

In 1822 Say described two species of *Donax* living in the surf zone of ocean beaches on the east coast of the United States. *Donax variabilis*, the southern form, occurring in Georgia and east Florida, while the more northern *Donax fossor* was reported from Maryland and New Jersey. In the original description there is very little to differentiate the two "species." The shell of *D. variabilis* was reported as "triangular; anterior margin obliquely truncated, cordate, suture a little convex; posterior hinge margin nearly rectilinear." The shell of *D. fossor* was described as "subtriangular; anterior margin short and rounded; posterior hinge slope rectilinear." Other features of shape were described identically. The size of *D. fossor* was given as, "Breadth from half an inch to three-fifths." *D. variabilis* was described as "Length half an inch. Width nine-tenths of an inch. Thickness seven-twentieths of an inch." *D. fossor* reportedly had "yellowish" and "whitish" varieties while the "usual varieties" of *D. variabilis* were "red, white, yellow or elegantly radiated with dilated reddish brown lines upon a white or yellow ground."

Since this original description the range of both species has been extended considerably. *D. variabilis* is found from Virginia Beach to Florida and Texas, while *D. fossor* is found from Long Island to Cape Hatteras, North Carolina (J. P. E. Morrison, personal communication).

The two "species" are currently distinguished by most authorities on the basis of size, shell color, sculpturing and thickness of the valves at the anterior end. *D. variabilis* reaches a maximum length of three-fourths of an inch, occurs in an almost infinite variety of colors, has a marked gradient of radial shell sculpture

¹ Contribution No. 312 from Virginia Institute of Marine Science.

² Present Address: Marinus Laboratories, P. O. Box 1330, Melbourne, Florida 32901.

that is more pronounced posteriorly, and a thickening of the valves at the anterior end to produce "lips." *D. fossor* reaches a maximum size of one-half an inch, reportedly occurs in only two color phases, has smooth radial sculpturing over the entire shell and does not have the thickened valves at the anterior end.

Some authors have accepted the validity of these two species or have at least treated them as separate species (Johnson, 1934; Morris, 1947; Miner, 1950). A few have suggested that the two are the same species. Abbott (1954), in describing *D. fossor* says, "Subsequent biological studies may show that this common beach species is a subspecies or cold-water form of *variabilis*. Young specimens of *variabilis* from several southern states look suspiciously like this so-called species." Jacobson and Emerson (1961) in discussing the periodic appearance and disappearance of *D. fossor* on Long Island stated "Because of this strange periodicity, some malacologists speculate that what we call *D. fossor* is merely *D. variabilis* (a large Florida *Donax*), the larvae of which have somehow been swept far to the north and developed poorly in our unfavorable waters. It is fairly certain that *D. fossor* does not survive the winter in our area." These remarks plus personal observation of the periodic occurrence of *Donax* on the Eastern Shore of Virginia prompted this investigation of *D. fossor* and *D. variabilis* to determine if they are two valid species.

This study would not have been possible without the cooperation and help of Dr. J. P. E. Morrison of the U. S. National Museum, Dr. Arthur H. Clark of the National Museum of Canada (who provided the information on the Canadian collections), Dr. R. Tucker Abbott of the Delaware Museum of Natural History, as well as Dr. Ruth Turner and Dr. Kenneth Boss of the Museum of Comparative Zoology of Harvard University. Mr. M. Karl Jacobson's data, suggestions, cooperation and encouragement were also of utmost importance. I am especially grateful to Mr. Wade B. Smith of the University of North Carolina for allowing me to use the excellent data from his thesis. Finally, and perhaps most important, I am indebted to the many members of the American Malacological Union who so thoughtfully provided the data essential to this study from their own collections.

MATERIALS AND METHODS

As a first step in this investigation a questionnaire was mailed to several members of the American Malacological Union requesting as much information as possible about their private collections of *Donax* from the East Coast of the United States, specifically the date and location of collections as well as the size of the specimens. Comparable data were obtained from the collections of the U. S. National Museum, the Academy of Natural Sciences of Philadelphia and the Museum of Comparative Zoology of Harvard University.

In order to estimate the time and duration of the spawning season, the gonad condition of *Donax* was determined whenever possible by dissecting fresh material and histological sectioning of preserved specimens. The presence of small (2-3 mm) clams in collections was also considered evidence of recent recruitment. To determine the length of the pelagic larval period, *Donax* were spawned in the laboratory and their larvae reared to metamorphosis.

The direction and velocity of coastal currents that might influence the distribution of clams were determined by reviewing pertinent literature.

RESULTS

Donax have been collected along the Atlantic Coast of the United States from Florida to Long Island and Connecticut. From Virginia northward, *Donax* have apparently never been collected alive from January to May 30 (Table I). On Long Island they cannot be found every year and sometimes as many as twelve years elapse between appearances (New York Shell Club Notes, 1967). They have been collected year round in North Carolina and southward.

North of North Carolina there is a general trend for the average size of *Donax* to increase as the season progresses, as determined by periodic observations throughout a season at one location in New York, New Jersey and Virginia (Table II). No such trend is evident in collections of *Donax* from North Carolina.

Gonad studies of clams were limited to those taken on April 4 and August 31 in North Carolina; from July to October on the Eastern Shore of Virginia; and on August 8 at Ocean City, New

Jersey. Usually only heavily parasitized clams lacked mature eggs or sperm in gonads. The occurrence of 3 mm and smaller clams from March to December in Smith's (thesis) North Carolina collections is further evidence of almost continual recruitment.

Table I. Number of collections of *Donax variabilis* and *D. fossor* by month. Collections of non-living material have been omitted only if the collector specified that the collection was of dead shells.

Month	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Long Island to Virginia	0	0	0	0	1	5	24	25	18	8	2	0	83
North Carolina to Florida	1	3	8	8	10	9	9	11	10	7	8	3	87

Under laboratory conditions larval *Donax variabilis* increased in length from 70 μ to a maximum of 350 μ during their pelagic period (Chanley, 1969). This is a greater increase in size during the pelagic stage than is found in larvae of most bivalves. The first larvae to metamorphose in the laboratory began "setting" at an age of about 3 weeks. Another brood of larvae, reared under less desirable conditions, remained pelagic for 56 days without metamorphosing. Mr. William Tiffany, III, of Florida State University, has also reared *Donax* larvae and has found that under laboratory conditions some larvae remain pelagic for up to 50 days. Rate of larval development is highly dependent on water temperature. Since laboratory temperatures were higher (20-25° C) than those in nature when *D. fossor* first appear as 5 mm clams (20° C), it seems probable that larvae could be pelagic for even longer periods. A reasonable estimate would be that some larvae remain pelagic at least 6 to 8 weeks in spring and fall with a minimum two-week pelagic period under optimum summer conditions.

Dispersal of the veliger larvae of marine bivalves is accomplished primarily by water currents. The pertinent water currents in the geographic range of *Donax* are the Gulf Stream and several less stable inshore current and eddy systems. The Gulf Stream moves north at about 50 miles per day (Svedrup *et al.*, 1942). Harrison *et al.* (1967) found the inshore current systems unstable but nonetheless capable of carrying drift bottles southward and shoreward from release point at average velocities of up to 24 miles per day or north at average velocities up to 11 miles per day (Table III).

DISCUSSION

Many factors must be considered in analyzing the distribution data. Several collections have been made of dead, even fossil, shell. They are of no value in establishing seasonal distribution because it is possible that these shells were transported to the point of collection after death of the clams. The inclusion of these "irrelevant" collections in the study is thought to be less detrimental than exclusion of any possibly pertinent data. Consequently, all dated collections have been used in this analysis unless the collector has specifically stated that clams were dead at time of collections.

The average lengths of clams must also be viewed with caution. Most collections do not represent random samples of a population and several collections contain too few specimens to get a valid estimate of average size. Finally, rates of growth may vary considerably at different levels of the intertidal zone or in different local colonies.

Considering these possible sources of error it is suprising how definitive the distribution and size data are. The only two northern

Table II. Average lengths of Donax collected periodically from established stations. Rockaway Beach, Long Island collections were made by M. K. Jacobson; Ocean City, New Jersey collections by Ron Lowden; Eastern Shore, Virginia collections by Mike Castagna and the author; the Emerald Isle and Fort Macon collections from Bogue Bank by Wade B. Smith.

Northern Stations									
Month	Rockaway Beach, Long Island	Ocean City, Maryland	Eastern Shore, Virginia						
	1954	1955	1967	1964	1968				
June									
July	5.7	5.9		4.5	5.2				
August	9.2	7.4		8.1	8.6				
September	9.7		8.5		13.2				
October	10.7		10.5		13.3				
			8.9*		13.5				

Bogue Bank, North Carolina									
Month	Emerald Isle		Fort Macon						
	1967	1968	1967	1968					
February		8.2							
March		9.0							
April		6.8							
May		8.8							
June		10.6							
July									
August	9.6		6.5	4.2					
September		5.2	4.6	3.4					
October	4.9		5.1						
November	4.8								
December	6.0		4.9						
	8.1		6.3						

* Average size decreased because a group of smaller clams (5-7 mm) appeared in the sample. The larger size group (10.5-14.5 mm) averaged 11.5 mm long.

(Long Island to Virginia) collections from January to June are the McCallum collection from Assateague Island in April and the Weingartner collection on 30 May from Beach Haven Inlet, New Jersey. The McCallum collection was of dead hinged valves on the bayside of the island. Since experimentally planted hinged valves of *Donax* can persist on the beach for several months (Loesch, 1957), it seems likely that these valves were of clams that had died the previous winter. On the other hand the clams in the Weingartner collection were living at the time of collection and were so large, averaging 13.6 mm in length, it seems likely they had survived the previous winter and were not an example of 1956 recruitment. This collection is the only record of living *Donax* north of Virginia before July. The Van Pelt collection in June was of beach-worn single valves.

Perhaps the most reasonable explanation for this peculiar distribution of *Donax* would be that *D. fossor* are really *D. variabilis* carried north as larvae in spring, summer and fall. These larvae survive in seasonably warm temperatures and develop into small clams on northern beaches. Growth and even reproduction continues until temperatures drop in the fall. Clams then become sluggish, unable to maintain themselves in the surf zone and are eventually killed. Living clams are not found again until subsequent recolonization occurs. Only rarely do conditions permit isolated populations, such as that sampled by Weingartner, to survive the winter.

This would not be a unique phenomenon. Coe (1953), on the west coast, observed, "By means of these currents the geographical range of a species with pelagic larvae may be extended in favorable seasons far beyond the usual limits but only to have the range restricted again when more vigorous conditions return. The population will thereby fluctuate irregularly in distribution-----."

Frequently the autumnal disappearance of *Donax* occurs while water temperatures are as high as the spring temperature when the clams first appeared. Certainly temperatures are usually higher at the time of disappearance than winter water temperatures in North Carolina where *Donax* can be found throughout the year. Consequently factors other than temperature may also be involved. For example, in late summer and early fall *Spisula solidissima* larvae frequently settle along northern ocean beaches and tem-

porarily establish dense populations of juveniles in *Donax* habitats. Direct competition with juvenile *S. solidissima* plus increased predation by birds, crabs, racoons and other predators contribute to the demise of *Donax* populations. Such pressures would be absent in spring and early summer when smaller, less conspicuous *Donax* colonize northern beaches and *S. solidissima* are absent. *S. solidissima* are less numerous on the beaches of North Carolina, near the southern limit of the range of this species.

Loesch (1957) observed that, in Texas, *Donax* moved into knee-deep water in December. I have found no evidence to suggest that offshore migration accounts for the fall disappearance of *Donax* north of North Carolina. In fact, reports of the simultaneous appearance of empty valves and disappearance of living clams strongly suggests death of the clams.

The hypothesis that *D. fossor* is a summer range extension of *D. variabilis* would not only account for the seasonal distribution of *Donax* in the mid-Atlantic region but would also account for the sporadic appearance of *Donax* on Long Island. Colonization of beaches at this northern limit of the range would depend on irregular fortuitous combinations of warm water currents that do not occur annually.

Table III. Inshore Non-tidal Current Direction and Velocity of Northern Chesapeake Bight (From Harrison et al., 1967).

Month	Predominant Non-tidal Surface Current Direction	Average Velocity Determined by Drift Bottles
August 1963	North and Shoreward	4 Nautical miles per day
March 1964	Shoreward	3.9 Nautical miles per day
April 1964	South	7.9 Nautical miles per day
May 1964	Inshore-North Offshore-South	2.3-11 Nautical miles per day 0.8-4.2 Nautical miles per day
June 1964	Mostly south and shoreward	1.5-24.2 Nautical miles per day
July 1964	Mostly north and shoreward	2.5 Nautical miles per day
August 1964	Mostly north and shoreward	Inshore 1.6-6.6 nautical miles per day Offshore 2.2-4.2 nautical miles per day

It would also account for the seasonal increase in average size of northern *Donax* that does not occur in North Carolina. Since all clams are of the one-year class their initial average size would increase during the year. In the south this effect would be masked by the presence of the previous year class and almost continual recruitment. Large North Carolina *Donax* frequently have a pronounced "growth" ring indicating that cessation of growth occurred seasonally. "Growth" rings are rare on more northern clams and when they do occur are probably indicative of individual cessation of growth due to injury, disease or some other non-seasonal causes. Bi-modal length-frequency distributions of northern populations would indicate discontinuous recruitment during the same season rather than two year classes.

The minor conchological differences between *D. fossor* and *D. variabilis* could be those of a population that does not overwinter compared to a population that does. They could also be induced by temperature or other environmental conditions. Wade (personal communication) has found that "different factors throughout the life cycle have effects which may give rise to much variability in shell morphology" of *Donax denticulatus*. Nicol (1967) noted that cold-water species of pelecypods had a general lack of color and subdued ornamentation. A comparable intra-specific phenomenon of less magnitude could account for the conchological differences between northern and southern *Donax*. The occurrence of "both species" on the same beach would indicate that the two morphological types had developed at different seasons or under different environmental conditions rather than as different species.

The length of the larval period of *Donax* plus the velocity of ocean currents show that it theoretically is possible for larvae to be transported from 700 to 2500 miles by the Gulf Stream during their pelagic period. The lengthy spawning period provides ample opportunity for larvae to be in the water for transport to the north during months they can survive. Thus annual repopulation of northern beaches by current transport of larvae from the entire Atlantic range of *D. variabilis* appears feasible.

After the relatively lengthy larval period clams become sexually mature rapidly and may reproduce in a few weeks. Juveniles have doubled in size in the laboratory one week after setting. Loesch

(1957) found sexually mature males and females only 4 mm long. Consequently, clams that have colonized a beach in late spring or early summer are capable of producing larvae that can repopulate still another beach the same summer. Therefore, recolonization of northern beaches is also possible by serial advance up coast.

It is more difficult to defend the hypothesis that *D. fossor* and *D. variabilis* are distinct species. The absence of *D. fossor* from December through May might be accounted for by lack of collecting effort during these months. However collecting effort should be greater in April and May when clams are not found, than in the fall when they have been found. It also seems unlikely that these clams assume habits that make them immune to collection from January to June but susceptible to capture the rest of the year.

If the two forms are distinct species the increase in average size during the season would indicate that clams "winter-over" as larvae or minute juveniles and resume growth when temperatures rise. They would then die as temperatures drop the following winter. This hypothesis does not seem likely since it requires the assumption that larvae and minute juveniles can survive the winter while half-grown and "adult" *D. fossor* cannot.

Finally *Donax* reproduce by releasing gametes freely into the water. The spawning periods of the two forms overlap and both have been collected from the same beach at the same time. It is difficult to understand how speciation could have occurred when there is no geographic or physical barrier and no selectivity in mating. Some mechanism for prevention of interbreeding would have to be demonstrated before the hypothesis that speciation has occurred could be accepted.

CONCLUSIONS

D. variabilis larvae are pelagic for several weeks and are exposed to water currents capable of transporting them great distances. In the summertime they would be expected to colonize northern beaches that are too cold for the species in wintertime. The distribution and growth of *D. fossor* are difficult to explain if *D. fossor* is a distinct species, yet they are precisely what one would expect of a summer range extension of *D. variabilis*. The conclusion is that *D. fossor* is *D. variabilis* and that the minor conchological differences, now used to separate them by many malacologists, are environmentally induced.

LOCALITY RECORDS

The dated collection records that have been obtained are listed as follows: Source of information (NMC, USNM, ANSP, MCZ, PC represent, respectively, National Museum of Canada, United States National Museum, Academy of Natural Sciences of Philadelphia, Museum of Comparative Zoology of Harvard University, and Private Collection), collector, location, year, days and months of collection and remarks. Remarks are enclosed in parentheses and apply only to the collection immediately preceding them.

New York

USNM: *Merriam*, Jones Beach, 1883 — 24 Sept. NMC, MCZ and PC: *M. K. Jacobson*, Rockaway Beach, 1949 — July; 1954 — 25 July; 8, 13, 26, 29 Aug.; 6, 14, 27, 28 (collected dead) Sept.; 3 (only 3 specimens); 10-12 Oct. (May have been collected dead); 28 Nov. (Beachworn valves): 1955 — 12, 19 July; 1, 3 Aug. PC: *E. Hartstein*, Fire Island, 1967 — Mid-Aug. (present only one day). PC: *V. Johns*, Atlantic Beach, 1967 — 4 Sept. (indirect report). PC: *J. Foehrenbach*, Fire Island, 1968 — July (No *Donax* found).

New Jersey

ANSP: *L. Woolman*, Holly Beach, 1894 — 7 Oct. ANSP: *P. H. Brown*, Wildwood, 1896 — July (single valves, probably fossil or subfossil). ANSP: *H. A. Pilsbry*, Sea Isle City, 1901 — July. ANSP: *S. S. Van Pelt*, Cape May County, 1907 — 9 June (Beachworn single valves). ANSP: *B. Long*, Ocean County, 1912 — 15-18 Sept. (only 2 specimens). ANSP: *D. McCadden*, Ocean City, 1916 — 2 Aug. ANSP: *H. A. Pilsbry*, Cape May, 1917 — Aug. ANSP: *H. R. Roberts*, Stone Harbor, 1939 — Aug. ANSP: *M. Wagner*, Beach Haven Inlet, 1940 — 5 July (3 Beach-worn single valves). PC: *R. E. Weidman*, Barnegat Bay, 1947 — Aug. ANSP: *R. A. Heilman*, Cape May County, 1953 — 12 July; 1954 — 12 Aug. PC: *M. Weingartner*, Beach Haven Inlet, 1956 — 30 May. PC: *G. and M. Kline*, Wildwood Crest, 1966 — 8 Oct. PC: *R. Lowden*, Ocean City, 1967 — 31 July; 1, 9 Aug.; 3 Sept.; 15 Oct. (two distinct size groups). PC: *M. Hulswit*, S. Hereford Inlet, 1967 — 11 Aug. PC: *C. Fisher*, Ocean City, 1968 — 8 Aug. *R. Fisher*, Ocean City, 1968 — 2 Sept. (*Donax* present, not collected); 1 Oct. (No *Donax* present).

Delaware

USNM: *Richards*, Delaware Bay near Lewes, 1931 — 4 Aug. (one specimen).

Maryland

USNM: *H. A. Rehder*, Ocean City, 1945 — 3 Aug. USNM: *J. P. E. Morrison*, Ocean City, 1963 — 7 July. PC: *M. Hulwit*, Assateague Island, 1967 — 15, 16 Aug. (two distinct size groups. Larger clams rare.)

Virginia

USNM: *Fish Hawk*, Lynnhaven Rd., 1916 — 15 July (probably not live collected); Magothy Bay. 1916 — 22 July (3 shells); Virginia Beach, 1916 — 25 July (1 valve). ANSP: *H. G. Richards*, Cape Charles, 1929 — 16 June (3 single valves); Cape Henry, 1931 — 29 Aug. (3 single valves). MCZ: *Glench, McCoy and Russell*, 10 miles S. Virginia Beach, 1934 — Aug.-Sept. USNM: *J. P. E. Morrison*, Northampton County, 1935 — 6 July; Virginia Beach, 1946 — 22 Sept.; 1950 — 23 July. USNM: *W. H. Ball*, Virginia Beach, 1943 — 5 Oct. ANSP: *R. & H. R. Robertson*, Cape Henry, 1962 — 22 July. PC: *P. Chanley*, Cedar Island, 1963 — 16 July to 8 Oct. (clams collected twice weekly); 1964 — 26 June; 9, 14, 21, 22, 27 July; Aug.; 17 Sept. PC: *G. & M. Kline*, Assateague Island, 1966 — 25 Nov. PC: *G. McCallum*, Assateague Island, 1968 — 18 April (dead shells collected on bay side of island). PC: *M. Castagna*, Near Wachapreague Inlet, 1968 — 10 June (none found); 17, 24 June; 16, 22 July; 1, 6, 14, 28 Aug.; 3, 16, 23, 30 Sept.; 7, 14 (none found), 21 (none found), 28 (none found) Oct.

North Carolina

USNM: Shackleford Beach, 1899 — Aug. USNM: *C. W. Stiles*, Southport, 1922 — Sept. (single valve). MCZ: *J. S. Colman*, Beaufort; USNM: *C. W. Cooke*, Cape Hatteras, 1936 — May. MCZ: *H. A. Vander Schallie*, Morehead City, 1937 — Sept. ANSP: *R. W. Kindle*, Atlantic Beach, 1938 — 1 Nov. (6 valves). USNM: *A. S. Pearse*, 1939 — 17 June. ANSP: *R. A. McLean*, Bogue Bank, 1942 — 17 July. USNM: *W. H. Ball*, Nag's Head, 1943 — 29 Sept.; Dare County, 1943 — 20 Oct. USNM: *J. P. E. Morrison*, Cape Hatteras, 1943 — 20 Oct.; Nag's Head, 1957 — 26 Aug.; Cape Hatteras, 1957 — 29 Aug.; Emerald Isle, 1960 — 9 June. PC: *W. B. Smith*, Bogue Bank, 1967 — 23, 25, 27, 28, 31 July; 18 Aug.; 11, 12 Sept.; 15 Oct.; 18, 19 Nov.; 16, 17 Dec.; 1968 — 19, 20, 27, 28 Feb.; 11, 14, 15, 18, 19 March; 12, 16, 17, 18 April; 13, 14, 16, 17, 22, 23, 24 May; 18, 19 June; 1, 3 July; 6, 7, 8, 19, 20 Aug. PC: *P. Chanley*, Bogue Bank, 1968 — 4 April. PC: *P. Jennewein*, Wrightsville Beach, 1968 — 19 May. PC: *D. Armstrong*, Nag's Head, 1968 — 31 Aug.

South Carolina

MCZ: Charleston, 1885 — May. MCZ: *E. B. Chamberlin*, Waverly Mills, 1929 — Sept. (Beach worn single valves). MCZ: *C. W. Johnson*, Folly Beach, 1931 — 27 March (single valves); ANSP: *F. Harper and A. N. Leads*, Myrtle Beach, 1933 — 5, 6 April (9 single valves, probably not live collected). ANSP: *E. M. Kindle*, Myrtle Beach, 1938 — Nov. (Single valves). ANSP: *H. G. Richards*, Ocean Drive Beach, 1941 — 10 May. ANSP: *L. Patterson*, Myrtle Beach, 1941 — June (3 single valves). ANSP: *Coventry and McLean*, Ashe Island, 1941 — 25 June (1 complete specimen

and one single valve). USNM: Myrtle Beach, 1946 — Sept. USNM: *H. A. Rehder*, Myrtle Beach, 1946 — Oct. ANSP: *H. G. Richards*, Myrtle Beach, 1947 — 4 March (single valves). USNM: *J. P. E. Morrison*, Myrtle Beach, 1955 — 3 Dec.; 1959 — 22 Nov.; 1960 — 7 June; Windy Hill Beach, 1960 — 7 June; Pawley's Island, 1960 — 15 Sept.; Near Little River Inlet, 1960 — 25 Sept. MCZ: *A. S. Merrill*, Racoon Key, 1963 — 1 July (1 drilled valve). MCZ: *G. McCallum*, Pawley's Island, 1966 — 14 Aug. MCZ: *B. & D. McCallum*, Litchfield Beach, 1966 — Aug. (Single valves).

Georgia

MCZ: *Clench, Archer and Rehder*, St. Simons Island, 1931 — July, Aug. USNM: *H. A. Rehder*, St. Simons Island, 1938 — Oct. ANSP: *McLean and Coventry*, Sea Isle, 1941 — June. NMC: *R. H. Croker*, Sapelo Island, 1964 — 27 Nov.

Florida

MCZ: *Clench and Okkelberg*, St. Augustine, 1929 — 19 July. USNM: *B. C. Marshall*, Near McIntyre, 1931 — July (3 specimens). MCZ: *R. W. Foster*, Ormond Beach, 1934 — March; Key Biscayne, 1936 — Feb. (2 specimens) Cape Canaveral, 1937 — April (3 specimens). USNM: *J. P. E. Morrison*, Duval County, 1936 — 27 April. MCZ: *E. M. Davis*, Fernandina, 1936 — Oct. (single worn valves). USNM: *M. MacNeil*, Volusia County, 1959 — 19 March (4 specimens). USNM: *R. O. Christenson*, Daytona Beach, 1939 — 19 April. ANSP: *F. Harper*, Ponte Vedra, 1941 — 20 May. MCZ: *R. T. Abbott*, Duval County, 1942 — Oct. ANSP: *E. M. Kindle*, St. Johns County, 1947 — 10 March (single specimen). MCZ: *H. D. Athearn*, Flagler Beach, 1949 — May (6 specimens). NMC: *P. Hooper*, Daytona Beach, 1955 — 14 July. USNM: *J. P. E. Morrison*, Daytona Beach, 1959 — 20 Nov.

LITERATURE CITED

- Abbott, R. T. 1954. American Seashells. Van Nostrand, Princeton, N. J. 541 p.
- Chanley, P. 1969. Larval development of the coquina clam, *Donax variabilis* with a discussion of the structure of the larval hinge in the Tellinacea. Bull. Mar. Science 19 (1): 214-224.
- Coe, W. R. 1953. Resurgent populations of littoral marine invertebrates, and their dependence on ocean currents and tidal currents. Ecology 34 (1): 225-229.
- Harrison, W., J. J. Norcross, N. A. Pore and E. M. Stanley. 1967. Circulation of shelf waters of the Chesapeake Bight. Professional Paper 3: 1-82. Environmental Sciences Services Administration. U. S. Dept. Commerce, Washington.
- Jacobson, M. K., and W. K. Emerson. 1961. Shells of the New York City Area. Argonaut Books, Larchmont, N. Y. 142 p.
- Johnson, C. W. 1934. List of marine mollusca of the Atlantic coast

- from Labrador to Texas, Proc. Boston Soc. Natural History 40 (1) : 1-204.
- Loesch, H. C. 1957. Studies of the ecology of two species of *Donax* on Mustang Island, Texas. Publ. Inst. Mar. Sci., Univ. Texas, 4 (2) : 201-227.
- Miner, R. W. 1950. Field book of seashore life. G. P. Putnam's Sons, New York. 888 p.
- Morris, P. A. 1947. A field guide to the shells. Riverside Press. Cambridge, Mass. 236 p.
- New York Shell Club Notes. September 1967. *Donax* on Long Island. No. 134: 2.
- Nicol, D. 1967. Some characteristics of cold-water marine pelecypods. Paleontol. 41 (6) : 1330-1340.
- Say, Thomas. 1822. An account of some of the marine shells of the United States. Acad. Nat. Sci. Phila. J. 2: 302-325.
- Smith, W. B. Thesis (In preparation). University of North Carolina.
- Sverdrup, H. V., M. W. Johnson and R. H. Fleming. 1942. The oceans, their physics, chemistry and general biology. Prentice Hall, Englewood Cliffs, N. J. 1087 p.

TWO INFRASUBSPECIFIC FORMS IN *OLIVA*

By ROWLAND F. ZEIGLER

305 West Palmetto St., Florence, South Carolina

There is perhaps more disarray in the genus *Oliva* than in any other group of shells. The writer, for the past several years, has been reviewing literature and studying collections both private and in museums, hoping that these efforts will culminate in the publication of a book with natural color photographs and proper synonymies. A contemporary review should be a welcome reference for the understanding and clarification of this misunderstood and neglected genus. Two shells have been encountered in these studies that appear deserving of new *forma* names. One of these is well-known but without an available name, while the other is quite uncommon and has been overlooked in the past. These new names are being proposed at the infrasubspecific level, and do not enter into the literature as pre-occupying subspecific names. Nor are they available as valid specific names.

Olive (Oliva) incrassata Lightfoot, 1786 (= *O. angulata* Lamarck, 1811)

The well-known Angled Olive, the heaviest member of the genus, varying in size from 50 - 88 mm. in length and up to 40 mm.

in width, is quite common and ranges from Lower California, throughout the Gulf of California, and down the Pacific coast to Peru. Many of these shells in the Gulf of California contain varying amounts of a brilliant golden-yellow coloration intergrading to a pure golden form. The only named color form is:

Oliva incrassata forma *nivea* Pilsbry, 1910

The rare pure-white albino found only in the northern end of the Gulf of California. (A rare unnamed glossy black form is also occasionally found.)

Oliva incrassata forma *burchorum* new form. Fig. 1.

This well-known, but heretofore unnamed form, is completely golden. It is felt that this form is worthy of a form name, just as the golden form of *O. sayana* Ravenel, 1834, on the Florida coasts merits the name *O. sayana* forma *citrina* Johnson, 1911. In its juvenile stage, the color is a deep-orange, tending to become more yellowish as the shell matures and develops its angular shoulder. Animals of both the golden and white forms are the usual buff color of typical *O. incrassata*. It is completely devoid of markings, rare, much-prized, and is known only from the northern end of the Gulf of California. Range — longitudes 113° west — 115° west, and latitudes 30° north — 32° north.

The holotype is in the American Museum of Natural History, New York City, No. 147749. The type locality is San Felipe, Baja California, Mexico. One paratype is in the collection of Mr. H. C. Porreca, West Henrietta, N. Y., and three are in the writer's collection, including the figured specimens.

The new name *burchorum* is proposed to honor John Q. and Rose L. Burch of California. No one in recent times has studied, written about, or contributed more to our knowledge of the genus *Oliva* than the Burch's. Their studies and voluminous notes on *Oliva* in the Minutes of the Conchological Club of Southern California (1958-60) have been of inestimable value. The Burch's reviewed and assembled the literature, and catalogued the Recent and Fossil Olives in 1960. They concluded that "there are a number of species to be described as new, and others that may prove to be variants of one species. These should be studied with care and published with proper illustrations." Their work, as well as their encouragement and assistance through personal communications, has been an inspiration.

Oliva (Oliva) tremulina Lamarck, 1811

This Indo-Pacific species has been controversial, as it is almost identical in appearance with *O. miniacea* Röding, 1798, long known as *O. erythrostoma* Lamarck, 1811 (non *O. erythrostoma* Meuschen, 1787, non binomial). The primary differentiating feature is that *O. tremulina* has a fleshy white aperture, while *O. miniacea* always has a deep reddish orange aperture. There are some parallel color variations in both species. *O. tremulina* like *O. miniacea* is elongated cylindrical, large, rather thick, longitudinally wave streaked and banded. Johnson and some other authors considered *O. tremulina* to be a form of *O. miniacea*. Burch felt that *tremulina*, in addition to the differentiating fleshy white aperture, was less swollen at the posterior or shoulder. He felt that they were otherwise close, but separable. Dautzenberg considered *O. tremulina* a valid species and named a color form. *Oliva nobilis* Reeve, 1850, is a synonym.

Distinct and recognized color forms of *O. tremulina* are:

Oliva tremulina forma *chrysoides* Dautzenberg, 1927.

A solid golden or orange form, which may have a very faint pattern. It is like *O. miniacea* forma *sylvia* Duclos, 1844, except for the white aperture.

Oliva tremulina forma *concinna* Marrat, 1871.

Uniform blackish brown in color, or sprinkled with a few triangular markings. Its counterpart is *O. miniacea* forma *marrati* Johnson, 1914.

Oliva tremulina forma *fumosa* Marrat, 1870.

Dautzenberg described this shell as "intermediate between typical *O. tremulina* and the variety *concinna*. The ground color is tawny-gray and the dark and cloudy pattern gives to the shell a smoky aspect. In certain examples, broad brown patches spread over much of the surface. The aperture is white and the lip is bordered with brown on the inside."

Oliva tremulina forma *olympiadina* Duclos, 1835.

A handsome Indian Ocean form which is always white, sometimes obscurely reticulated with purplish brown, but always having a more calloused white columella and white aperture. Johnson called this shell an albinistic form of *O. tremulina*.

Oliva tremulina forma *oldi*, new form. Fig. 2.



Fig. 1. Two paratypes of *Oliva incrassata* Lightfoot *forma burchorum* Zeigler. San Felipe, Baja California, Mexico. 35 and 41 mm. in length.

This is a distinctive and constantly marked shell, characteristically grayish in overall appearance, though background color is creamy yellow. Longitudinal charcoal zigzag lines usually crossed by two solid or broken dark transverse bands. Somewhat similar in pattern and markings to *O. textilina* Lamarck, 1810, but longitudinal lines are not so closely spaced as in that species. No matching color form in the species *O. miniacea* have been observed. Base of columella adorned with orange, above which is a heavy dark brown fasciole. Length 50-56 mm. Not common. Type locality: Bougainville Island, Solomon Islands. Additional specimens from Luzon, Philippine Islands, and Manus Island, Admiralty Group. Range — longitudes 120° east — 158° east and latitudes 8° south — 15° north.

The holotype is now in the American Museum of Natural History in New York City, No. 147750. There are four paratypes, two of which are in the author's collection (the figured specimens) and one each in the collections of John Q. Burch, Seal Beach, California and Walter G. Krause, Avoca Beach, N.S.W., Australia.

Many years ago, Dr. Howard Hill, former Curator of Marine Zoology at the Los Angeles County Museum, sent several speci-

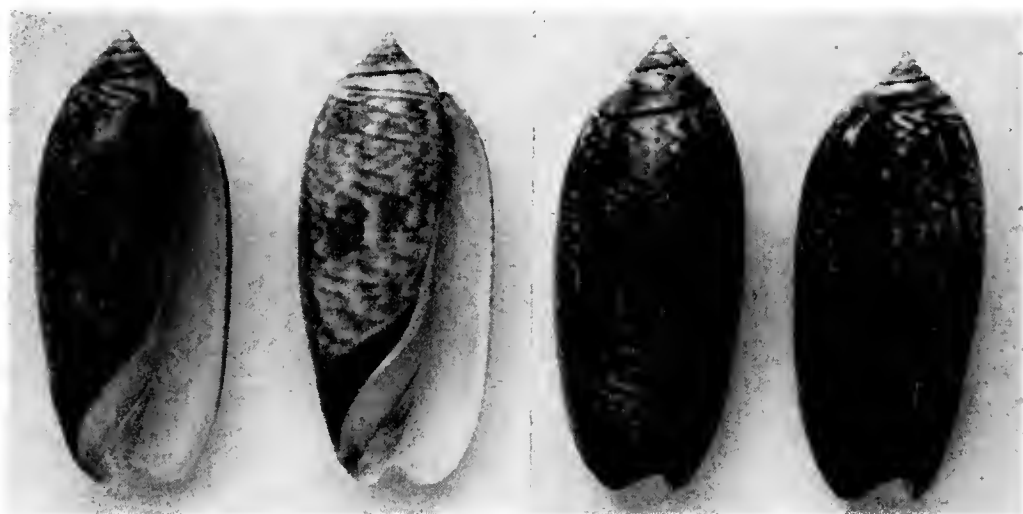


Fig. 2. Two paratypes of *Oliva tremulina* Lamarck form *oldi* Zeigler. Bougainville Island, Solomon Islands. Both 54 mm. in length.

mens of this shell to the writer labelled "unidentified from Bougainville." More of the same shells have since been obtained from Bougainville, as well as from Manus Island, and one from the Philippines.

Other specimens were found in the American Museum of Natural History collection, and William E. Old, Jr., supplied several specimens, all of which came from Bougainville. The name *oldi* is here proposed for this color form in honor of William E. Old, Jr., who has done much work and research on the genus *Oliva*, and who has been of invaluable assistance.

LITERATURE REFERENCES

- Burch, John Q. and Burch, Rose L. 1960. Catalogue of Recent and Fossil Olives. Issue 196 of Minutes of the Conchological Club of Southern California.
- . 1960. Minutes of the Conchological Club of Southern California. Issues 181-195.
- . 1967. The Family Olividae. Pacific Science, Vol. 21, No. 4, 503-522.
- Dautzenberg, Ph. 1927. Olividés de la Nouvelle Calédonie et de ses dépendences. J. Conchy. 71: 1-72, 103-147.
- Duclos, P. L. 1835, 1840. Histoire naturelle . . . de tous les genres de coquilles univalvès marins à l'éta vivant et fossile, publié par monographies. Genre *Olive*. Paris.
- . 1844-48. *Oliva*, In: J. C. Chenu, Illustrations conchyliologiques. Paris.

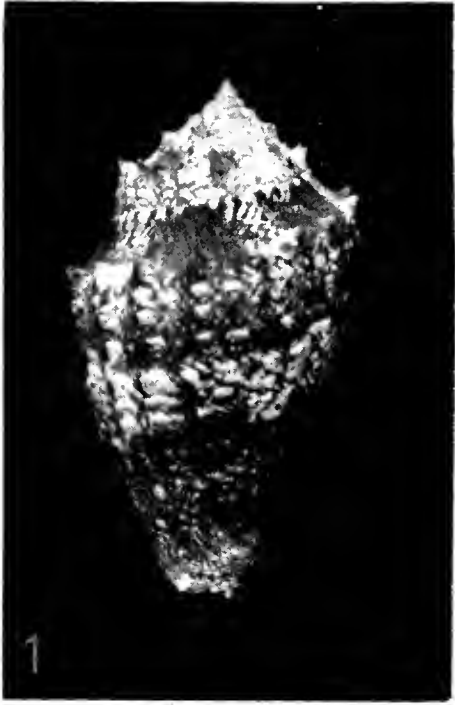
- Hill, Howard R. 1954. Variation in the Olive Shells of Tropical West America. *Nautilus*, Vol. 68 (2) : 66-69.
- Johnson, Charles W. 1910-1911. Some notes on the Olividae. *Nautilus* 24: 49-51, 64-68, 121-124.
- . 1915. Further notes on the Olividae. *Nautilus* 28: 97-103, 114-116.
- . 1928. A review of certain species of the Olividae. *Nautilus* 42: 6-13.
- Lamarck, J.B.P.A. de M. de. 1811. (Suite de la) Détermination des espèces de mollusques testaces; continuation du genre *Ovule*, *Tarrière* *Ancillaire* et *Olive*. *Mus. Hist. Nat. (Paris)* 16 (for 1810) : pp. 89-114, 300-328 (Jan.-Mar., 1811).
- Marrat, F. P. 1870-71. *Oliva* Bruguière. In: G. B. Sowerby, *Thesaurus Conchylionum*. Vol. 4, pls. 328, 329-41, 342-51 (*Oliva*, pls. 1-25).
- Reeve, Lovell. 1850. *Conchologia Iconica*: or illustrations of the shells of molluscous animals. Monograph of the genus *Oliva*. pls. 1-30. London.
- Tryon, G. W., Jr. 1883. *Manual of Conchology*. Ser. 1, Vol. 5. Philadelphia.

GALAPAGAN RECORDS FOR MORUM VELEROAE (GASTROPODA: TONNACEA)

By WILLIAM K. EMERSON
American Museum of Natural History

Morum (Cancellomorum) veleroae Emerson (1968b, p. 53, pl. 1, figs. 1-7) was recently described by the writer on the basis of five sub-adult specimens obtained by dredging, in 1938, off Cocos Island, some 325 miles southwest of Costa Rica. Shortly after my manuscript, describing this interesting species was accepted for publication, Mesdames Carmen Angermeyer and Jacqueline DeRoy each reported (*in litteris*) taking living specimens of this species by dredging in the Galápagos Islands. Through the kindness of these industrious collectors, I can now provide additional data resulting from the Galapagan specimens.

Mrs. DeRoy dredged two living specimens in 100 meters near Tagus Cove, Isabella Island, on January 28, 1968. One is a large specimen measuring 52.2 mm. in length and 27.8 mm. in greatest diameter. This specimen, here illustrated as figs. 1, 2, possesses a very thin, immature, outer lip and it has not developed the parietal callus. The small tonnacid operculum has a marginal nucleus and concentric growth lines. A radula is wanting. The second



Morun (Cancellomorum) veleroae Emerson, 1968

Figs. 1, 2: off Isabella Island [Albemarle Island], Galapagos Islands, in 100 meters, DeRoy coll., X 1. Note the lack of development of a parietal callus and the immature outer lip; operculum is attached to a cotton plug in aperture of specimen.

Figs. 3, 4: off James Island [San Salvador Island], Galapagos Islands, in 69 meters; ex-Angermeyer coll., A.M.N.H. No. 152606; X 1.3. Note the well-developed parietal callus and mature outer lip.

specimen, which measures approximately 42 mm. in length, also possesses an immature outer lip.

Mrs. Angermeyer dredged a specimen in about 69 meters on coral and sand bottom off the southern coast of James Island, on June 14, 1968. She noted that the animal was similar to that of *Morum (Morum) tuberculosum* Reeve, 1842, with the body a light gray with black mottling. Her specimen here illustrated as figs. 3, 4, is approximately 38 mm. in length (nuclear whorls missing) and is about 24.3 mm. in greatest diameter. The shell, which has a well-developed parietal callus and an apparently mature outer lip, is more vividly colored than the type specimens, which are somewhat faded, as they were collected some thirty years ago. The parietal callus of this smaller, but more mature specimen, was a glossy raspberry-red before the shell was preserved in alcohol, whereas that of the type material is a pinkish lavender. The dorsum of the shell is overgrown with calcareous algae.

Mrs. Angermeyer (*in litteris*) also reports obtaining a well-preserved, dead specimen off northern James Island, in 69 to 80 meters, on coral and sand bottom, June 16, 1968. This specimen, which is approximately 42 mm. in length and 25 mm. in width, has longer and more prominent spines on the shoulder than those possessed by the specimen she collected alive.

With the discovery of the four Galapagan specimens of *Morum (Cancellomorum) veleroae*, a total of nine examples are now known, including the five specimens of the type lot from Cocos Island. The largest individual, measuring nearly 53 mm. in length, is the DeRoy specimen from the Galápagos Islands (figs. 1, 2). The smallest specimen is a juvenile, measuring approximately 22 mm. in length, of the type lot from Cocos Island (Emerson, 1968b, pl. 1, figs. 6, 7). The specimens were dredged from depths ranging from 57 to 91 meters off Cocos Island, and 69 to 100 meters in the Galápagos Islands, on sand, coral, and coralline substrates. Living examples of its western Atlantic analogue, *Morum (Cancellomorum) dennisoni* (Reeve, 1842) have been collected in 62 to 139 meters, with a medium depth of 110 meters, on coral, rocky, and sponge substrates (Dance and Emerson, 1967, p. 94). Future dredging operations along the continental shelf of the west American mainland, within the Panamic faunal province, should

reveal the presence of *Morum* (*Cancellomorum*) *veleroae* living at moderate depths on appropriate substrates.

Six living species of *Morum* (*sensu lato*) are known to occur in warm to tropical waters of the New World, four in the Western Atlantic and two in the eastern Pacific (Emerson, 1968a). The only other West American Recent representative of this genus is *Morum* (*Morum*) *tuberculosum* (Reeve, 1842), a shallow-water species of the nominate subgenus. Reeve's taxon also is represented in the western Atlantic by an analogue, *Morum* (*Morum*) *oniscus* (Linné, 1767), the type species of *Morum* Röding, 1798.

LITERATURE CITED

- Dance, S. P., and W. K. Emerson. 1967. Notes on *Morum dennissoni* (Reeve) and related species. *Veliger*, 10 (2) : 91-98, pl. 12.
- Emerson, W. K.
- 1968a. The American species of the genus *Morum*. *Ann. Repts. Amer. Malacol. Union for 1967*, pp. 74-75.
- 1968b. A new species of the gastropod genus *Morum* from the eastern Pacific Ocean. *Journ. Conchyl.*, Paris, 107 (1) : 53-57, pl. 1.

NORTHERN RANGE EXTENSION AND WINTER MORTALITY OF *RANGIA CUNEATA*

BY JOHN L. GALLAGHER AND HARRY W. WELLS

Department of Biological Sciences
University of Delaware, Newark, Delaware

The brackish water mactrid clam, *Rangia cuneata* (Gray), until recently was believed to occur no farther north than Virginia (Abbott, 1968). This species occurs at Roanoke Island, North Carolina, and Wass (1963) found it was abundant in the James River, Virginia. Pfitzenmeyer and Drobeck (1964) have more recently reported it from the Potomac River. Because this species is harvested for food from various estuaries along the Atlantic and Gulf coasts, the extent of its northward migration is of special interest.

In October, 1967, four living specimens of *Rangia cuneata* were dredged from the tidal waters of North East River, Maryland, at the head of Chesapeake Bay (39° 32' N, 75° 59' W). This collection was made in approximately six feet of water. A year later (December 30, 1968), thousands of shells of this species were found washed onto the shore of the Elk River near Thackery Point (39° 28.5' N 75° 58.3' W), about five miles south of the first collection

site. The latter location is along the waterway leading to the Chesapeake and Delaware Canal which connects Chesapeake Bay with Delaware Bay.

The probable cause of the mass mortality observed in Elk River was low temperature. A similar mass mortality had been observed here in the winter of 1966-67. Heavy ice conditions occur most winters in the Elk River, occasionally requiring ice breaker assistance for ships *en route* to and from the Chesapeake and Delaware Canal. At the time the dead *Rangia* were observed in 1968, ice lined the shore although the deep water channel was free of ice. The victims of this mortality probably came from the shallows where the stress of low temperature would be greatest. Under these physical conditions, clams in deep water could survive and maintain the population in this area.

Salinity conditions within the Elk River (0.3‰ in January, 1969) are an unlikely alternative cause of death, because *Rangia cuneata* has been reported living in the Potomac River in a similar salinity regime. However, low salinity may have increased stresses upon clams at low temperatures. Pollution is considered unlikely as a cause of the mortality because no other species was

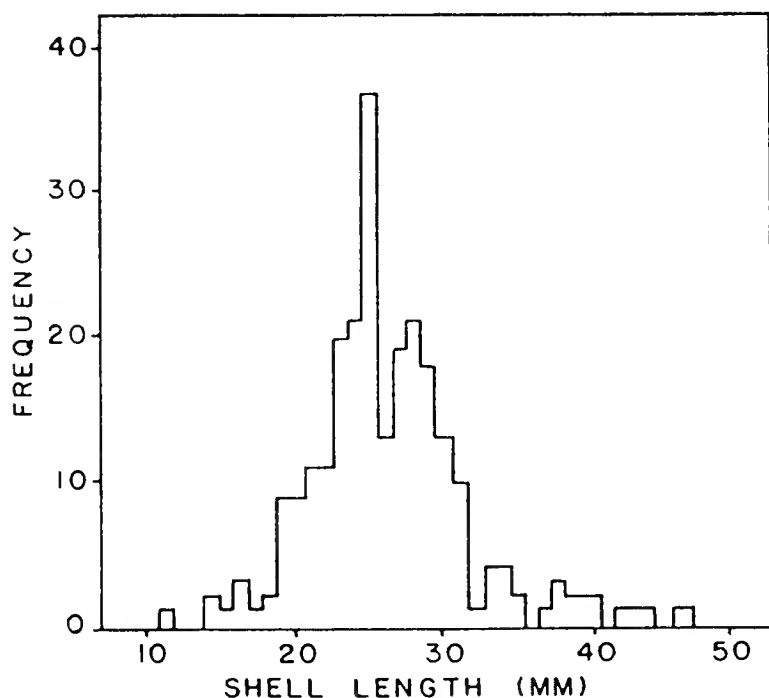


Fig. 1. Length distribution of *Rangia cuneata* from Elk River, Maryland, December 30, 1968.

found to have succumbed. As a crude assay, water samples taken at the time of collection were found to support developing frog embryos and tadpoles.

From a representative sample of 244 specimens collected from a 200-yard section of the beach, the length-frequency distribution shown in Fig. 1 was constructed. Shell lengths ranged from 11 to 46 mm., with a mean of 26 mm. and a standard deviation of 5.2 mm. In comparison with data presented by Pfitzenmeyer and Drobeck (1964) for clams from the Potomac River, the shells from Elk River have a greater average length. At present, however, it is not known if this mortality were selective, or if the dead clams were indeed representative of the total living population in that river. Lengths reported by Wolf and Petteway (1968) for *Rangia cuneata* at different ages, and observations of growth rings on these shells indicate that the Elk River mortality involved individuals ranging from one to four years old. In most cases, the flesh of the clams was badly decomposed at the time of collection.

Pfitzenmeyer and Drobeck (1964) suggested that *Rangia cuneata* may have been introduced to the Potomac River with seed oysters. Because the oyster bars closest to the Elk River are approximately 30 miles away in Chesapeake Bay, it is conceivable that this clam has spread northward from the oyster growing area. Pfitzenmeyer and Drobeck considered the possibility that, after many years' presence elsewhere in the Potomac River drainage system, this species had expanded its distribution to areas where it attracted biologists' attention. However, they discounted this possibility since no sudden environmental changes had been noted which could be correlated with the clams' discovery. In the absence of marked recent changes in the local environment, their conclusion seems applicable to the Elk River situation. If future surveys show this population to be relatively isolated, it would increase the probability of man's introduction of *Rangia cuneata* into the immediate area, possibly in waste from dredge gear or spoil barges.

On the other hand, winter kills in the Elk River suggest that this species is approaching its natural northern geographic limit under present climatic conditions. Richards (1938) has reported fossil *Rangia cuneata* in New Jersey, indicating former Pleistocene extension into that state, but he could find no living specimens. The sea-level canal connecting Chesapeake Bay to Delaware Bay

presents an opportunity for the transport of larvae and reproductive stages of aquatic organisms tolerant to brackish waters. The larvae of *Rangia cuneata*, described by Chanley (1965), can readily be transported in this fashion. The proximity of the canal to the Elk River collection site makes it probable that *Rangia cuneata* will be found living in brackish waters of the Delaware Bay system, paralleling the record of its Pleistocene distribution in that area.

Specimens have been deposited in the United States National Museum, Division of Mollusks.

LITERATURE CITED

- Abbott, R. T. 1958. Seashells of North America. Golden Press, New York. 280 pp.
- Chanley, P. E. 1965. Larval development of the brackish water mactrid clam, *Rangia cuneata*. Chesapeake Sci. 6 (4) : 209-213.
- Pfitzenmeyer, H. T., and K. G. Drobeck. 1964. The occurrence of the brackish water clam, *Rangia cuneata*, in the Potomac River, Maryland. Chesapeake Sci. 5 (4) : 209-212.
- Richards, H. G. 1938. Animals of the seashore. Bruce Humphries, Inc., Boston. 273 pp.
- Wass, M. L. 1963. Check list of the marine invertebrates of Virginia. Va. Inst. of Marine Science, Spec. Sci. Rept. 24. 56 pp.
- Wolfe, D. A., and E. N. Petteway 1968. Growth of *Rangia cuneata* Gray. Chesapeake Sci. 9 (2) : 99-102.
-

A NEW CAECUM FROM THE TROPICAL WESTERN ATLANTIC¹

By DONALD R. MOORE

Institute of Marine Sciences, University of Miami

In the summer of 1968 I was asked by George Radwin, then a predoctoral fellow at the U. S. National Museum, to check his identification of some marine micromollusks. The material came from Payardi Island on the Atlantic side of Panama. The island is adjacent to the city of Colon, in the Canal Zone.

An unusual specimen of the family Caecidae was included in the material. As it was a single specimen, it was put aside. A few weeks later, I was invited by Helmer Odé and Harold Geis to look over the Caecidae collected in their Texas off-shore survey. There was a wealth of material and again a single specimen of the unusual *Caecum*. Since the two specimens were clearly conspecific, it was decided to describe the species.

Caecum condylum, new species

Description: The teleoconch of *C. condylum* is cylindrical and only slightly curved for most of its length. The anterior part near the aperture is more strongly curved. Near the aperture there is a broad rounded swelling or varix. Shortly beyond this the shell terminates at the aperture.

The septum is slightly depressed and the low, somewhat pointed mucro is angled to the right. The aperture is circular and is about the same diameter as the shell on the proximal side of the varix. The ground color is white with several diffuse bands of light brown.

The sculpture consists of approximately 100 low close set annular ridges. They continue over the varix on to the aperture.

The ridges do not increase in size on the varix. The protoconch and second stage are unknown. The operculum was not observed.

Material. Holotype. Payardi Island, near Colon, on the Atlantic side of Panama. Length, 2.40 mm. Division of Mollusks, U. S. National Museum, no. 679348. Paratype. A single specimen from 27° 54' 30" N., 93° 35' 45" W., East Flower Garden Bank, Gulf of Mexico, coral debris, 18.3-23.8 m., length, 3.36 mm. Division of Mollusks, U. S. National Museum, no. 679349.

¹ Contribution No. 1033. from The Institute of Marine Sciences, University of Miami, Miami, Florida.

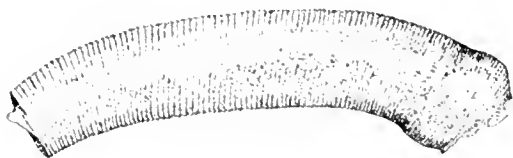


Fig. 1. *Caecum condylum* new species. The holotype as seen from the right side. There is a slight break in the aperture.

Name. From *condylus*, the enlarged end of a bone.

Remarks. There is a considerable difference in size in the only two specimens available. They are contrasted below.

	<i>Holotype</i>	<i>Paratype</i>
Total length	2.40 mm.	3.36 mm.
Anterior diameter	0.44	0.56
Posterior diameter	0.40	0.56
Varix diameter	0.56	0.76

The chief difference in the two specimens is size. In all other respects they are closely similar. Both appear to be fully mature.

I have examined thousands of specimens of Caecidae from the western Atlantic. In all that material, it seems strange that there would be only two specimens of the new species from localities some 1500 miles apart. A possible explanation might be that it occupies a restricted habitat, and that this habitat has been little sampled for micromollusks.

C. condylum does not appear to be very closely allied to any western Atlantic species. *C. subvolutum* Folin and *C. veracruzatum* Folin are similar in shape, but they do not have the axial ridges. Those species with axial ridges, such as *C. pulchellum* Stimpson, have them much larger and fewer in number. *C. clava* Folin has an even larger terminal varix and longitudinal sculpture. Even immature specimens of *C. condylum* should be fairly easy to identify.

At first glance it would seem that this species should go into the genus *Micranellum* Bartsch 1920. The type of the genus is *Caecum crebricinctum* Carpenter 1864. In 1866, Carpenter noted that *C. crebricinctum* had the aspect, but not the sculpture of an *Elephantulum*. In this latter genus, the sculpture supposedly consists of longitudinal ridges only. Unfortunately, there are the two ex-

tremes of sculpture development, and, as more species are examined, it is seen that there is a gradual transition from one type to another.

A species being described from the Virgin Islands as *Caecum insularum* (Moore, in press) is very similar in appearance to *C. crebricinctum*. Chief differences are fewer axial ridges and the presence of very weak longitudinal ridges in *C. insularum*. This species is in turn very close to *C. imbricatum* Carpenter, a species in which axial and longitudinal sculpture is nearly equal.

C. crebricinctum is also quite similar to *C. imperforatum* Kammacher, the type species of *Caecum*. Even the coloration is much the same and the principle differences are size and number of axial ridges. The entire family seems quite homogenous, and all subdivisions should probably be at the subgeneric level. It may not be possible to separate *Caecum* s.s. from *Micranellum*. Bartsch (1920) mentions that five of the species he placed in *Micranellum* have bulbous swellings at the end of the teleoconch. This would seem to justify the establishment of a new subgenus based on *C. condylum* and the possibly related Pacific coast species, but Bartsch did not really describe any of his species nor did he figure any. Until the Pacific coast material can be examined carefully, it is best to refer the new species herein described to the genus *Caecum* without increasing the list of supraspecific names.

ACKNOWLEDGEMENTS

I am grateful to the Division of Mollusks, U. S. National Museum, for the opportunity to describe the species. I also wish to thank Harold Geis and Helmer Odé for contributing the paratype from Texas. This work was supported by National Science Foundation Grant GB-5055 (UM N8753). The excellent drawing of the holotype was made by Mrs. Barbara Lidz.

LITERATURE CITED

- Bartsch, P. 1920. The Caecidae and other marine mollusks from the northwest coast of America. J. Wash. Sci., 10 (20): 565-572.
Carpenter, P. P. 1864. Supplementary report on the present state of our knowledge with regard to the Mollusca of the west coast of North America. Rept. British Assoc. Adv. Sci. 1863: 517-686.
———. 1866. Descriptions of new marine shells from the coast of California. Pt. III. Proc. Calif. Acad. Sci., 3: 207-224.
Moore, D. R. (in press) A new *Caecum* from Puerto Rico and the Virgin Islands. Bull. Mar. Sci.

NOTES ON THE BIOLOGY OF THE SNAIL *SONORELLA ODORATA* IN ARIZONA¹

By LANCE H. GILBERTSON
Orange Coast College, Costa Mesa, California

Most species of *Sonorella* inhabit rock slides of the arid and semi-arid slopes of the Lower and Upper Sonoran Life Zones in Arizona, New Mexico and Sonora, Mexico. *Sonorella odorata* Pilsbry & Ferriss is exceptional ecologically, being a forest snail of the mesic Canadian Life Zone (usually between 7,500 and 9,000 feet). It is definitely known only from the Santa Catalina Mountains near Tucson, Arizona. Its supposed occurrence in the nearby Rincon Mountains has not been confirmed in recent years (Miller, 1967).

Pilsbry's name "*Sonorella odorata*" was based on populations which were later segregated as the nominate subspecies, *viz.*, *Sonorella odorata odorata*. Another subspecies *S. o. marmoris* inhabits the upper talus slopes of Marble Peak in the same mountain range. "*S. odorata*" will refer here to the nominate subspecies only.

The present study was conducted at Bear Wallow, located near the north-facing slope of Mt. Lemmon at approximately 8,000 feet. This is near the type locality of *S. odorata*, "at the head of Alder Canyon." The forest floor here is generally shaded, damp, and deep with decaying plant litter.

When disturbed, *S. odorata* emits an unpleasant, mephitic odor which accounts for its specific trivial name. However, it was never observed ejecting drops of odoriferous fluid as Ferriss reported.

Feeding habits — *S. odorata* is nocturnal, and only under artificial conditions has it been observed feeding during daylight hours. Therefore, to investigate its normal feeding habits under natural conditions, several trips were made at night to Bear Wallow. The results of these field observations and subsequent laboratory analyses of digestive tract contents indicate that the principal food items are: (1) decaying wood, bark, needles and forest litter in general, and (2) lichens, especially the plentiful foliose *Usnea sp.* as well as the more crustose forms. In addition, the snail has been observed feeding on a large red-capped mush-

¹ This paper is an abridgment of a portion of the biological data in a thesis submitted for the M.S. degree in Zoology at the University of Arizona, Tucson, in January 1965.

room, a rotting mushroom, a fallen green leaf (apparently of a columbine) and debris of a Douglas Fir cone. A specimen in the laboratory was observed consuming its epiphragm upon emerging from estivation.

Mating — Mating occurs only during summer months in the field, but throughout the year in the laboratory. In both places it was observed primarily at night, but on occasion also during daylight hours. Copulation is reciprocal and simultaneous, and has been timed to last from 2 min. 45 sec. to 9 min. No special precopulatory behavior was observed. Mating individuals were observed in Bear Wallow on the night of September 21, 1964, very near the end of their active season.

Oviposition and Development — Egg laying has been observed only after drenching summer rains. It was observed by the author on August 4, 6, and 12, 1964. The snail burrows with the anterior portion of its body about 1.5 cm. below the surface of the soil. The eggs are then laid in spiral fashion with each layer consisting of six to seven eggs surrounding a central one. The amount of time needed for oviposition was not determined; however, one individual was observed in the typical egg-laying position for almost 5 hours. The length of time between copulation and oviposition remains uncertain, due in part to the reluctance of *S. odorata* to lay eggs in the laboratory. In one instance, however, it apparently was about 45 days.

The incubation period in the laboratory at 75° F ranged from 15 to 20 days. Under natural conditions, however, incubation possibly lasts longer; in one observed cluster the eggs showed no signs of advanced development after 17 days. When the embryonic snail is fairly well developed, it rotates incessantly within the egg membrane. Many structures are easily visible at this time, including the shell, body proper, tentacles with eye-spots and even the beating heart. After several hours of rasping at the egg membrane, the young snail pulls free from the egg and accompanying mucus. The new-born snail weighs just slightly under 0.01 gm. Its shell has already acquired the characteristic brown color and is covered with fine, hair-like projections.

Hibernation — *S. odorata* spends most of its life in hibernation. Only during the summer rainy season does it emerge to feed and reproduce. It is found hibernating under large branches, logs,

amongst debris of wood and bark, under rocks, in rock crevices, in the soil, and perhaps most often under large flattened pieces of bark. Typically, the snail lies with the aperture facing upwards. The aperture is closed with a brilliant orange muco-calcareous epiphragm; during the course of hibernation, additional, much lighter and thinner epiphragms are formed internally. One snail, found on November 4, 1964, had already formed two such additional epiphragms.

S. odorata often hibernates gregariously. For example, in March 1963, Dr. Walter B. Miller uncovered a "pocket" of some 20 individuals hibernating in close proximity in the soil. On another occasion, the author discovered nine hibernating *S. odorata* under a large, flat piece of bark within 10 cm. of each other. However, many have been found hibernating alone.

Near the end of hibernation, individuals weigh less than active ones, but more than those which had estivated in the laboratory (at 75° F) for an equivalent length of time (Fig. 1).

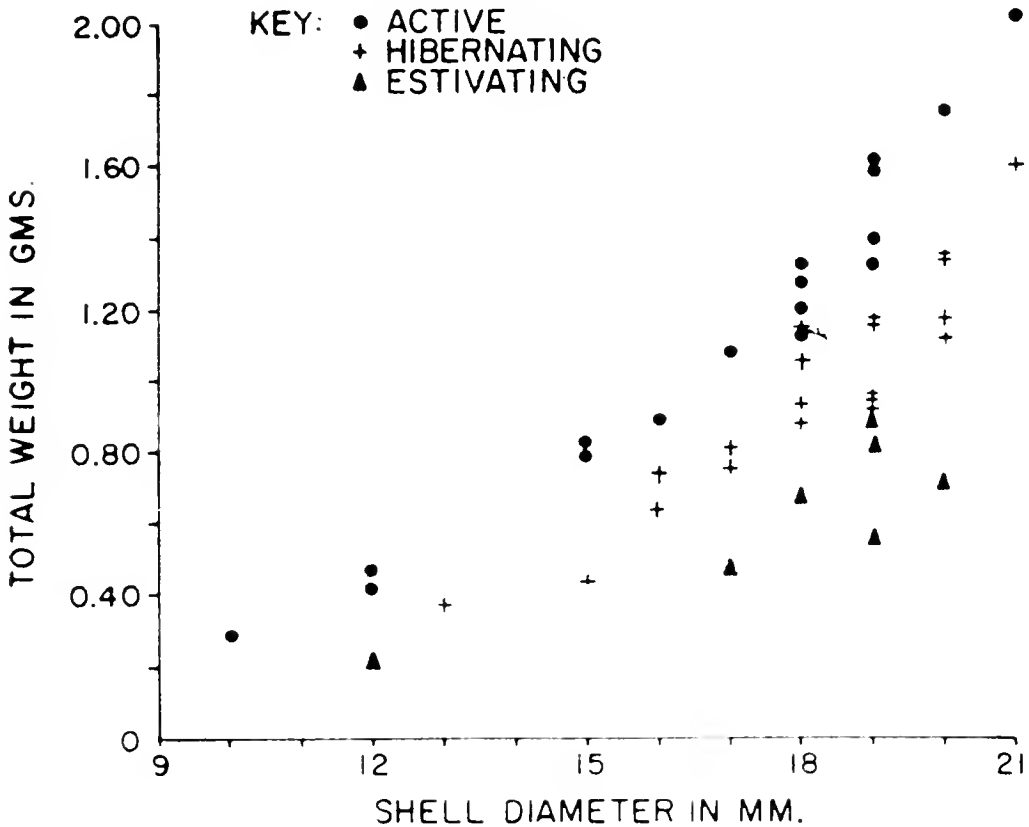


Fig. 1. Comparative weights of *S. odorata* in (1) the active state, (2) after ca. 8 months of hibernation, and (3) after ca. 8 months of estivation.

Estivation — Estivation occurs rather commonly in natural as well as laboratory based populations. In both situations, a few individuals usually could be found estivating even when environmental conditions seemed ideal for active life. This phenomenon, therefore, may be cyclic or periodic in nature as suggested in the research of Howes and Wells (1934).

Estivating *S. odorata*, unlike those in hibernation, are usually sealed to some object by their calcareous mucus. This mucus is never the brilliant orange color characteristic of the primary epiphragm secreted by hibernating individuals; rather, it is much lighter and resembles the more internal secondary epiphragms. The snail is able to withstand prolonged periods of estivation; but this capability is not essential for survival under prevailing environmental conditions. Of 13 individuals, 7 survived 8 months of estivation in the laboratory (at 75° F and low humidity). Mature individuals lost from 39 to 59 percent of their body weight (less shell). However, one small, immature snail lost only 10 percent of its body weight.

Association with fungi — The role of land pulmonates in the germination and dissemination of fungal spores has been commented on by several investigators. The present study represents an effort to define those types of fungi, found in the digestive tracts of *S. odorata*, which were able to grow on artificial nutrient media.

Five laboratory based specimens and six specimens collected at Bear Wallow on August 4, 12, and 18, and September 16, 18 and 21, 1964 were used. The entire digestive tracts were removed, rinsed in sterile water and triturated with a sterile mortar and pestle. Petri dishes containing Malt-Yeast Extract Agar with a pH of 4.0 were then inoculated and incubated at room temperature. As colonies developed, they were transferred to test tubes with slants of Malt-Yeast Extract Agar for subsequent identification.

Several species of fungi were isolated from both groups. Those isolated from the digested tracts of laboratory based *S. odorata* were: three *Mucor* Mich. ex Fr. spp. including *Mucor ramanianus* Moeller; three *Mortierella* Coemans spp.; two *Penicillium* Link ex Fr. spp.; *Syncephalastrum* Schroet. sp.; and *Trichoderma lignorum* Harz. Fungi isolated from snails collected in their natural habitat were: three *Trichoderma* Pers. ex Fr. spp., including *T. album* Preuss and *T. koningi* Oudemans; four *Mucor* Mich.

ex Fr. spp., including *M. ramannianus*; six *Penicillium* Link ex Fr. spp. including the strongly fasciculate *P. clavigerum* Demelius; *Pullularia* Berkh. sp.; *Diplodia* Fries sp., and *Cephalosporium* Corda sp.; *Mucor ramannianus* and one other *Mucor* sp. were the only two species common to both groups. *M. ramannianus* showed up in every laboratory based snail and in three of the six snails collected in their natural habitat. This was particularly significant, since it had not been previously isolated from this area despite extensive soil sampling by Dr. Adelaide Evenson Riker. A third *Mucor* sp., characterized by a yellowing of the mycelium with age, was isolated from the digestive tracts of all six specimens taken from the natural habitat, but never showed up in the laboratory based snails. This suggests either a definite relationship between *S. odorata* and this fungus, or an ubiquitousness of its spores. The regular isolation of at least three *Mortierella* spp. from the laboratory based group also seems significant, since species of this genus are not commonly obtained from soil samples. Unfortunately, however, they were not isolated from any of the six specimens comprising the natural habitat group. The genera *Penicillium* and *Trichoderma* were well represented in both groups, but by differing species. *T. album* and *T. koningi* were both isolated twice from different snails in the natural habitat group. No myxomycete growth was observed.

I wish to thank Drs. Albert R. Mead and Joseph C. Bequaert for their guidance and encouragement throughout the course of this investigation and the preparation of this paper. I also wish to express my indebtedness to Dr. Adelaide Evenson Riker of the Department of Microbiology, University of Arizona, who directed and assisted me in all phases of the mycological studies, and made all of the identifications.

LITERATURE CITED

- Howes, N. H. and G. P. Wells. 1934. The water relations of snails and slugs. I. Weight rhythms in *Helix pomatia* L. II. Weight rhythms in *Arion ater* L. and *Limax flavus* L. Jour. Exp. Biol., 11: 327-351.
- Miller, Walter B. 1967. Anatomical revision of the genus *Sonorella* (Pulmonata: Helminthoglyptidae), 293 p. (Ph.D. dissertation, Univ. of Arizona, Tucson).
- Miller, M. C. 1961. Distribution and food of the nudibranchiate

- mollusca of the South of the Isle of Man. J. Anim. Ecol. 30: 95-116.
- Moore, George M. 1968. Personal Communication, University of New Hampshire, Durham, N. H.
- Odhner, Nils Hj. 1929. Aeolidiiden aus dem nördlichen Norwegen. Tromsø Museums Arsh. 1: 1-22.
- Odhner, Nils Hj. 1939. Opisthobranchiate mollusca from the western and northern Coasts of Norway. Norske Vid. Selsk. Skr. 1: 1-93.
- Sars, G. O. 1878. Bidrag til kundskaben om Norges Arktiske Fauna. I. Mollusca Regionis Arcticae Norvegiae. Christiania.
- Swennen, C. 1961. Data on distribution, reproduction and ecology of the nudibranchiate molluscs occurring in the Netherlands. Neth. J. Sea Res. 1: 191-240.
- Thompson, T. E. 1964. Grazing and the life cycles of British nudibranchs. Brit. Ecol. Symp. 4: 275-297.
-

FURTHER ADDITIONS TO THE UNIONID FAUNA OF THE GULF DRAINAGE OF ALABAMA, GEORGIA AND FLORIDA

BY RICHARD I. JOHNSON
Museum of Comparative Zoology

In 1967 and 1968, I reported on the additions to the unionid fauna of the Apalachicolan region which have been made since the study of Clench and Turner (1956). Recently, through the kindness of Dr. William H. Heard of Florida State University, Tallahassee, who sent some specimens to the Museum of Comparative Zoology, I am able to report on two more species previously unknown from the Apalachicolan region, and on the extension of the ranges of two others.

Anodonta suborbiculata Say is widely distributed throughout the Interior Basin, extending south to Louisiana. It occurs in the Escambia River system at Gantt Lake, an empoundment on the Conecuh River, Clearview, Covington Co., Alabama. Although I am not aware of any records of this species in the neighboring Alabama-Coosa River system, it would be surprising if it does not occur there.

Anodonta couperiana Lea was previously thought to be limited to the Southern Atlantic Slope and Peninsular Florida regions (Johnson, 1965, pl. 1). It occurs in the neighboring Apalachicola and Ocklockonee river systems. In the former, at Apalachicola

River, Ocheesee Landing, 6 miles North of Blountstown, Calhoun Co., Florida and in the latter at Ocklockonee River, 11 miles North of Tallahassee, Leon Co., Florida. The discontinuous distribution of this species like a number of others, may be explained by a former confluence of the headwaters of the Apalachicola and Savannah river systems.

Fusconaia escambia Clench and Turner was known only from the Escambia River system when it was described. It also occurs in the Yellow River system, at Yellow River, 4 miles West of Crestview, Okaloosa Co., Florida.

Obovaria rotulata (B. H. Wright) was formerly known only from the type specimen from the Escambia River system. It has since been found there, in the Escambia River, Molino, Escambia Co., Florida and in the Conecuh River, 1 mile South of East Brewton, Escambia Co., Alabama.

LITERATURE CITED

- Clench, William J. and Ruth D. Turner. 1956. Freshwater mollusks of Alabama, Georgia, and Florida, from the Escambia to the Suwannee River. Bull. Florida State Mus., 1: 97-239, pls. 1-9.
- Johnson, Richard I. 1965. A hitherto overlooked *Anodonta* (Mollusca: Unionidae) from the Gulf drainage of Florida. Breviora, Mus. Comp. Zool., No. 213: 1-7, pls. 1-2.
- . 1967. Additions to the unionid fauna of the Gulf drainage of Alabama, Georgia and Florida. Breviora, Mus. Comp. Zool., No. 270: 1-21, pls. 1-3.
- . 1968. *Elliptio nigella*, overlooked unionid from Apalachicola river system. Nautilus, 82 (2) : 22-24, plate.

NOTES AND NEWS

DATES OF THE NAUTILUS. — Vol. 82, no. 1, pp. 1-36, was mailed July 24, 1968. No. 2, pp. 37-76 on Oct. 28, 1968. No. 3, pp. 77-114 on Jan. 31, 1969. No. 4, pp. 115-148 on April 28, 1969. — R. T. ABBOTT.

ECOLOGICAL DISTRIBUTION of the Non-marine Gastropods of the Olympic Peninsula, Washington, is the subject of a Sigma Xi 1969 grant recently made to Dr. Branley A. Branson of Eastern Kentucky University.

CONCERNING RAWSON'S PHYSA. — Bland and Binney, in 1873 (Ann. Lyc. Nat. Hist. N. Y., 10: 255-257), described and figured the lingual dentition of a species of *Physa* from Guadeloupe. They obtained the specimen from Governor Rawson of Guadeloupe who had earlier received it from the naturalist H. Schramm. The snail was thought to have been collected in the vicinity of Point-a-Pitre and was unusual in that the jaw and radula more nearly resembled those of the Lymnaeidae and Planorbidae than of the Physidae. The shell, however, was typically physoid.

Bequaert and Clench (J. Conch., 21: 175-178) compared Bland and Binney's figures with material from *Plesiophysa ornata* (Haas), and concluded that Rawson's *Physa* was a member of the genus *Plesiophysa*; they placed the species in synonymy with *Plesiophysa guadeloupensis* (Máze).

In examining a series of old slides deposited in the Museum of Comparative Zoology at Harvard University, I found one labeled "Rawson's *Physa*" and signed W. G. Binney. The date and journal citation of Bland and Binney's article also appeared on the label. Although the slide was badly broken and the mounting medium dried and cracked, details of the radula and jaw were observable. The rachidian tooth had 6 cusps, typical of the genus *Plesiophysa*. The marginals were not as figured by the original authors, but were morphologically similar to those of *P. ornata* as figured by Bequaert and Clench (loc. cit.) and by Hubendick (Arkiv. f. Zool., 42: 1-10). There were marked vertical striations on the dorsal portion of the jaw, and chitinous material suggestive of lateral processes were noted. These two characters are absent in *P. ornata*, but have been observed in Puerto Rican *P. hubendicki* by Richards and Ferguson (Trans. Am. Microscop. Soc., 81: 251-256). There appears to be little doubt that Rawson's *Physa* was a species of *Plesiophysa*, possibly *P. hubendicki*. Until the morphology of *P. guadeloupensis* is known, however, it is uncertain whether *P. guadeloupensis* and *P. hubendicki* are the same or not. Thus, the specific identity of Rawson's *Physa* remains questionable. — EDWARD H. MICHELSON, Dept. Trop. Public Health, Harvard School of Public Health, Boston. (Under Training Grant A1-00046 from the U. S. Public Health Service.)

R. TUCKER ABBOTT, who has been acting editor of the *Nautilus* during 1968, has resigned from the Academy of Natural Sciences of Philadelphia to join the newly founded Delaware Museum of Natural History, Greenville, Delaware 19807. He will fill the du Pont Chair of Malacology and also serve as an Assistant Director of the museum. *Indo-Pacific Mollusca* is now being published by the Delaware Museum of Natural History, and Dr. Abbott will continue to serve as editor of that journal and the *Nautilus*. Dr. H. B. Baker will continue to review the non-marine papers submitted to the *Nautilus*. From July 1 to December 31, 1969, Dr. Abbott will spend part of his time revising *American Seashells* at the Academy of Natural Sciences, 19th and Parkway, Philadelphia, Pa. 19103. Suggestions and corrections to *American Seashells* are welcomed, and *Nautilus* manuscripts may be sent either to Dr. Abbott in Philadelphia or to Dr. Baker in Havertown.

GEORGE MITCHELL MOORE. 1906-1968. — Professor George Mitchell Moore died at his home in Durham, New Hampshire, on May 19, 1968. Born in Shelby County, Ohio, August 5, 1906, he received the B.Sc. (1928) from Otterbein College, M.S. (1932) and Ph.D. (1938; Zoology, Limnology) from the University of Michigan. He taught in Ohio and Minnesota and was assistant Professor at Bowling Green State from 1938-42. He conducted research on the biology of *Volsella demissus* and *Crassostrea virginica* as an associate biologist for the Virginia Fisheries Laboratory, College of William and Mary in 1942-44. In 1944 he became associate professor at the University of New Hampshire, was made full professor in 1949, and served as Chairman of the Department of Zoology from 1947-63. While at UNH, Dr. Moore developed graduate and undergraduate courses in littoral marine invertebrate zoology, revitalized interest in estuarine research and was instrumental in establishing a Ph.D. curriculum in zoology. During 1958-59 he was Fullbright Lecturer at Chulalongkorn, Bangkok, Thailand, where he studied marine mollusks. The object of his research in recent years was the nudibranchs of New England and his comprehensive collection of these shell-less opisthobranchs has been placed in the Division of Mollusks, U. S. National Museum, Smithsonian Institution, Washington D. C. — JOSEPH ROSEWATER.

PUBLICATIONS RECEIVED

- McMillan, Nora F. 1968. *British Shells*. xii + 196 pp., 80 pls. (24 in color). 50 shillings (\$6.00). Frederick Warne and Co., Ltd., London. An excellent handbook covering the marine, land and fresh-water mollusks of the British Isles.
- Grassé, Pierre-P. (editor). 1968. *Mollusques Gastéropodes Scaphopodes*, vol. 5, fascicule 3 of the *Traité de Zoologie — Anatomie Systématique, Biologie*. 1083 pp., 517 text figs., 1 color plate. Masson et Cie., 120 Boulevard Saint-Germain, Paris 6, France. About \$58.00. An extensive coverage of the prosobranchs and opisthobranchs (by Andre Franc); evolution and paleontology of the gastropods (by G. Termier and H. Termier); neurosecretion and endocrines in mollusks (by M. Martoja); and the scaphopods (by E. Fischer-Piette and A. Franc). The nomenclature of the prosobranch taxa is, in some parts, out of date.
- Thompson, Fred G. 1969. *The Aquatic Snails of the Family Hydrobiidae of Peninsular Florida*. Univ. of Florida Press, Gainesville, \$8.00, 268 pp., 69 pages of excellent figures of shells, opercula, radulae, verges, soft parts and distributional maps of 36 Florida hydrobiids, including 23 new species and the new genera *Heleobops*, *Onobops*, *Hyalopyrgus*, *Aphaostrakon* and *Spilochlamys*.
- Purchon, R. D. 1968. *The Biology of the Mollusca*. Pergamon Press, London and N. Y., \$27.00, 560 pp., 185 figs. Extensive and well-illustrated chapters on the Mantle Cavity, Feeding Methods, Adaptive Radiation, Digestion, Reproduction, Distribution, and reviews of the seven classes (includes Aplousobranchia) of Mollusca.
- Boss, Kenneth J. 1969. *The Genus Strigilla; The Subfamily Tellininae in the Western Atlantic*. *Johnsonia*, vol. 4, no. 47, pp. 345-366, pls. 164-171. Excellent coverage of the six known species, including *pseudocarnaria* Boss, n. sp.
- Johns, Veronica P. *She Sells Seashells*. 198 pp. Plates on front and back covers. Funk & Wagnalls division of Reader's Digest Books. \$5.95. A charming and witty account of Mrs. Johns' experiences in her New York shell shop. Delightful reading — B.B.B.
-

WILLIAM H. WEEKS SHELL COLLECTION: New price lists of this famous collection, with full scientific data, are in preparation. Many new additions of fine and rare species are also included. To obtain free copies write:

GEORGE E. JACOBS, 853 Riverside Drive, New York 32, N. Y.

THE
NAUTILUS

THE PILSBRY QUARTERLY
DEVOTED TO THE INTERESTS OF CONCHOLOGISTS

EDITORS AND PUBLISHERS

HORACE BURRINGTON BAKER, 11 Chelten Road, Havertown, Pa.
(Emeritus Professor of Zoology, University of Pennsylvania)

R. TUCKER ABBOTT, duPont Chair of Malacology
Delaware Museum of Natural History, Greenville, Del. 19807

CHARLES B. WURTZ, *Biology Department*
La Salle College, Philadelphia, Pa. 19141

CONTENTS

On the feeding of the nudibranch, *Coryphella verrucosa rufibranchialis*, with a discussion of its taxonomy. By M. Patricia Morse 37

A new northern record for *Bursatella leachii pleii* Rang (Opisthobranchia), with notes on its biology. By W. L. Kruczynski and Hugh J. Porter 40

Succinea bakeri Hubricht. By Leslie Hubricht 42

Nonmarine mollusks of the Katalla region, Alaska. By S. J. Tuthill and Robert L. Johnson 44

Illustrations of Lamarck's types of North American Unionidae, mostly in the Paris Museum. By Richard I. Johnson 52

Nomenclatorial note: Arctiidae versus Cyprinidae (Mollusca; Bivalvia). By Kenneth J. Boss 61

Marine mollusks of Port Moller Bay, Alaska Peninsula. By James X. Corgan 65

Notes and news 66 Publications received 75

\$4.25 per year (\$4.75 to Foreign Countries) \$1.25 a copy.

Mrs. Horace B. Baker, Business Manager
11 Chelten Road, Havertown, Pennsylvania 19083

Second-Class Postage paid at Spring House, Pa.

NAUTILUS:

A Quarterly Journal devoted to the study of Mollusks, edited and published by HORACE B. BAKER, CHARLES B. WURTZ and R. TUCKER ABBOTT.

AUTHORS PLEASE NOTE:

Matter for publication should be sent to the acting editor, Dr. R. Tucker Abbott, Delaware Museum of Natural History, Greenville, Delaware 19807. *Manuscripts should be typewritten and DOUBLE SPACED throughout, including titles, footnotes and bibliographies. Please give reprint order, if any.*

Please correct and return galley proof (submitted without manuscript) quickly. Changes from manuscript, as edited, may be disregarded.

Authors are charged for engraving blocks of plates and/or figures at cost. Minimum charge for each block is \$3.00.

REPRINTS are furnished at printer's rates. ORDERS SHOULD BE WRITTEN ON OR ATTACHED TO FIRST PAGE OF MANUSCRIPT. REPRINTS are shipped, with invoices, by PONY PRINTING, 4 Cloverdale Avenue, Upper Darby, Pennsylvania 19082. PURCHASE ORDERS, when required, and shipping instructions, *MUST* accompany original orders. Extra clerical or bookkeeping work because of delayed receipt of purchase orders will be charged for accordingly:

TEXT PAPER	2 pp.	4 pp.	8 pp.	12 pp.	16 pp.
First, 100 copies	3.40	6.35	13.25	18.70	23.95
Additional 100 .....	.65	1.40	4.30	5.50	6.70
PLATE PAPER					
First 100 copies	3.70	6.90	14.45	20.45	26.25
Additional 100 .....	.90	1.95	5.45	7.25	9.00

Prices subject to change without notice. Postage extra.

THE NAUTILUS is the official organ of the American Malacological Union. Information regarding membership in the Union may be obtained from Mrs. Margaret C. Tesky, Secretary, Route 2, Box 318, Marinette, Wisconsin 54143.

BACK ISSUES: Vols. 3-70, if available, can be obtained from KRAUS PERIODICALS, INC., 16 East 46th Street, New York, N. Y. 10017. Vols. 71 to date are available from the NAUTILUS, 11 Cheltenham Road, Havertown, Pennsylvania 19083, and vary in price.

FOR SALE: Bound set of the Nautilus, vols. 56 through 79 and the Index to vols. 35-60. In 7 excellent dark green buckram bindings. \$150.00. George F. Kline, c/o The Editor, Nautilus.

THE NAUTILUS

Vol. 83

October, 1969

No. 2

ON THE FEEDING OF THE NUDIBRANCH, *CORYPHELLA VERRUCOSA RUFIBRANCHIALIS*, WITH A DISCUSSION OF ITS TAXONOMY

By M. PATRICIA MORSE

Northeastern University, Marine Science Institute, Nahant, Massachusetts

The nudibranch mollusk, *Coryphella verrucosa rufibranchialis* (Johnston 1832) as defined by Odhner 1939, has been observed to feed upon the ascidian, *Botryllus schlosseri* (Pallas 1766). The observations and experimentation on this prey-predator relationship reported in this paper were made at the Marine Science Institute, Nahant, Massachusetts, during January, February and March, 1968.

Coryphella verrucosa rufibranchialis has been reported to feed on hydroids by Miller (1961), Swennen (1961) and Thompson (1964). In the investigations of these authors, there is no record of any member of the family Coryphellidae feeding on an ascidian. Swennen (*l.c.*) suggests a definite list of criteria for the acceptance of a food-organism as important to the nudibranch. The criteria are: 1) association of the nudibranch with the food-organism in the field, 2) observation of the nudibranch feeding in the laboratory or in the field and 3) subsistence on the food-organism alone for some period of time.

The nudibranchs were first seen feeding on the ascidian on the sides of the 12' by 4' laboratory floor tanks and observations over several months revealed small and large specimens of *C. v. rufibranchialis* associated with the colonies of ascidians. It was noted that the cerata of the feeding nudibranchs all appeared chocolate brown in color. In order to observe actual feeding and color change of the cerata, *Coryphella verrucosa rufibranchialis* were collected from the Nahant rocky shore and placed in 10" finger bowls with the food organism, *B. schlosseri*. Growths of the ascidian on *Ascophyllum nodosum* were utilized for the experiments. Observations of the actual feeding process were made under a dissecting microscope.

The nudibranchs approached the food-organism and used the sensory oral tentacles for positioning the mouth opening. Utilizing the radula, the mollusk grazed on individual zooids of the star-shaped cluster, scraping away the tunic and ingesting the softer portions of the ascidian. Food was seen passing through the esophagus into the stomach. Contents of the stomach and digestive glands (which extend into the cerata) became dark chocolate-brown in color, approximating the color of the prey, and the fecal pellets were dark red-brown in color. (It is interesting to note that *Dendronotus frondosus* (Ascanius 1774) has also been observed feeding on *B. schlosseri* and ingests the tunic, individual zooids and common matrix of the prey with no color changes in the nudibranch.) Nudibranchs used in the experiments showed variation in the color of their cerata from a bright red to a darker red-brown. In the case of those with bright red cerata, the color progressively turned to dark red-brown as the nudibranchs continued to feed on *B. schlosseri*. Animals maintained on the ascidian for three weeks copulated and deposited numerous strings of eggs.

Observations on *C. v. rufibranchialis* in January 1969 showed that when animals with bright red cerata were placed in a finger bowl with *Syncoryne mirabilis* Agassiz 1862, the cerata turned a salmon-red color which approximated the color of the hydroid.

DISCUSSION

In 1909 Balch recognized two varieties of *Coryphella rufibranchialis* on the basis of distinct color variations among nudibranchs collected at Gloucester, Massachusetts. He assigned the names *C. rufibranchialis mananensis* (Stimp.) and *C. rufibranchialis chocolata* var. nov. The late Dr. George M. Moore (personal communication) collected the variety (*C. r. chocolata*) during the month of April in Rye, New Hampshire and Kittery, Maine. He compared the radulae of the two varieties and did not find any differences. An examination of his radular preparations verifies this. Balch (*l.c.*) postulated that *C. r. chocolata* might be "a mere physiological phase" and the evidence herein bears that out.

It must be noted that all specimens of *Coryphella verrucosa* (M. Sars, 1829) recorded from New England have been the variety *C. verrucosa rufibranchialis* as designated by Odhner (1939). In Odhner's synonymy and consequent acceptance of two subspecies to account for the extreme forms of *C. verrucosa*, he relied

on the reports and investigations of Friele and Hansen (1875), Sars (1878), and Loyning (1922). It is evident in the records of these latter investigators that *Coryphella verrucosa verrucosa* is a variety found only in Norwegian waters and thus has a very limited distribution while *Coryphella verrucosa rufibranchialis* has a wide boreal-arctic Atlantic distribution. In discussion of intermediate forms of *C. rufibranchialis* and *C. verrucosa* and the radula of the two typical forms Loyning (*l.c.*) stated that there were no distinguishing characteristic differences in the radulae. The figures of the radula of *Coryphella verrucosa* by Friele and Hansen (1875), of *Coryphella rufibranchialis* by G. O. Sars (1878) and of *Coryphella rufibranchialis* by Odhner (1929) are mutually similar and agree with observations made by the present author of the radulae from specimens of *Coryphella verrucosa rufibranchialis* along the New England Coast. However it is most unfortunate that Odhner (1939) figured the radula of a *Coryphella verrucosa rufibranchialis* (Fig. 21, p. 59) which is not compatible with his 1929 figure nor with any other morphological report on the radula of the subspecies.

It appears that the variety names accepted by Odhner (1939) should be maintained in the literature until additional knowledge of the breeding cycle, veliger shells and other characteristics verify the relationship between *Coryphella verrucosa* and *Coryphella rufibranchialis*.

Sincere thanks are due Dr. E. Deichmann for aid in translation of the Norwegian papers.

LITERATURE CITED

- Balch, Francis N. 1909. A spring collecting trip. Notes on New England Nudibranchs II. Nautilus 23: 33-38.
- Friele, H. and G. A. Hansen. 1875. Bidrag til Kundskaben om de norske nudibranchier. Vidensk. Selsk. Forh. Christiania.
- Loyning, Paul. 1922. Nudibranchfaunaen i Drobaksundet. I. Fam. Aeolididae. Vid. Selsk. Skr. I. Mat.-Nat. Klasse, No. 6. Kristiania.
- Miller, M. C. 1961. Distribution and food of the nudibranchiate mollusca of the South of the Isle of Man. J. Anim. Ecol. 30: 95-116.
- Moore, George M. 1968. Personal Communication, University of New Hampshire, Durham, N. H.
- Odhner, Nils Hj. 1929. Aeolidiiden aus dem nördlichen Norwegen. Troms Museums Arsh. 1: 1-22.
- Odhner, Nils Hj. 1939. Opisthobranchiate mollusca from the

- western and northern Coasts of Norway. Norske Vid. Selsk. Skr. 1: 1-93.
- Sars, G. O. 1878. Bidrag til kundskaben om Norges Arktiske Fauna. I. Mollusca Regionis Arcticae Norvegiae. Christiania.
- Swennen, C. 1961. Data on distribution, reproduction and ecology of the nudibranchiate molluscs occurring in the Netherlands. Neth. J. Sea Res. 1: 191-240.
- Thompson, T. E. 1964. Grazing and the life cycles of British nudibranchs. Brit. Ecol. Symp. 4: 275-297.
-

**A NEW NORTHERN RECORD FOR BURSATELLA
LEACHII PLEII RANG (OPISTHOBRANCHIA),
WITH NOTES ON ITS BIOLOGY**

BY WILLIAM L. KRUCZYNSKI AND HUGH J. PORTER
University of North Carolina Institute of Marine Sciences,
Morehead City, North Carolina

Bursatella leachii pleii Rang, the ragged sea hare, can now be added to the list of tropical animals known from the coast of North Carolina, U. S. A. The specimens here reported were identified from descriptions of Eales and Engel (1935) and Henry (1952).

Circumtropical in distribution, the species is divided into six geographical subspecies (Eales and Engel, 1935). *B. l. pleii* is common throughout the West Indies. Henry (1952) gives its previous northern record as Alligator Harbor, Florida. Abbott (1954, 1968) reports it only from the west coast of Florida and the Caribbean.

A population of 27 individuals was found in two of six newly constructed concrete holding ponds at the Institute of Marine Sciences, Morehead City, North Carolina, and was kept under casual observation from 21 September until 26 December, 1968. Each pond measures 29 x 19.5 x 2.7 feet and contains approximately 11,400 gallons of sea water, which is continuously pumped from nearby Bogue Sound.

Salinity and temperature measurements in the ponds were recorded throughout the observation period. Salinity fluctuated slightly about 30 ppm. Water temperature dropped steadily from 29° C. (24 September) to 3.5° C. (21 December) when it remained constant for nearly a week.

On 23 October, all specimens were removed from the ponds and measured. Mean total length was 138 mm.; mean width across the branchial cavity, 52 mm. Henry (1952) found the average length and width of 100 living specimens from Alligator Harbor to be 135 and 75 mm. respectively. Although our specimens were not measured initially, we believe they grew appreciably after first observation.

Eight individuals were remeasured on 12 December when the water temperature was 10° C., but the remainder could not be found because of cloudiness of the water. All animals found were alive, but sluggish. Average length and width had decreased to 123 and 65 mm. respectively. However, because of low temperature the specimens may not have been fully extended. We noted later that an indication of death was noticeable decrease in size. Wet weights of the eight individuals were found to average 134 grams which is above the averages (111 and 80 g.) recorded between March and June in Alligator Harbor by Henry (1952).

Copulatory chains were observed from 21 September through 3 December. Although egg masses were deposited throughout this period, and at temperatures as low as 10° C., incubation in the laboratory showed that eggs did not hatch in water colder than 15° C. We observed that animals cleared an area on the side of the pond by rasping away algae before depositing eggs. Characteristics of egg masses agreed with description of Henry (1952). Cylindrical egg strings contained a mean number of 53 spherical loculi per cm., and within each loculus there was an average of 28 eggs or embryos.

Although individuals remained alive at 8° C., they were sluggish and were not observed to feed. The entire population died when temperature dropped to 3.5° C., for several days. Before death each animal extended the gill through the branchial opening. (Preserved specimens, catalogue #2532, are in the mollusk collection of the University of North Carolina, Institute of Marine Sciences.)

It is not known how these animals entered the two ponds. Possibly they were attached as eggs to the shells of *Glycymeris americanus* DeFrance placed in the ponds on 29 June, 1968. These bivalves, dredged off Cape Fear, North Carolina, had remained out of water two days before being placed in the ponds. A more proba-

ble method of entrance was as larvae through the sea-water system. Because the walls of the ponds are covered with barnacles, tunicates and other encrusting organisms, it is known that larval forms can pass unharmed through the pumping system. Regardless of which mode of entrance is correct, the finding of *B. l. pleii* in North Carolina is a new geographical record for the subspecies.

ACKNOWLEDGMENTS

We are grateful to Dr. F. Schwartz, University of North Carolina Institute of Marine Sciences, who first called this population to our attention.

LITERATURE CITED

- Abbott, R. T. 1954. American Seashells. D. Van Nostrand Co., Inc., Princeton, New Jersey.
- . 1968. Seashells of North America, A Guide to Field Identification. Golden Press, New York, New York.
- Eales, N. B. and H. Engel. 1935. The genus *Bursatella* de Blainville. Proc. Malac. Soc. London, 21: 279-303.
- Henry, L. M. 1952. Observations on the sea hare *Bursatella leachii pleii* Rang. Stud. Fla. Univ., 1 (7) : 8-14.

SUCCINEA BAKERI HUBRICHT

By LESLIE HUBRICHT

4026 - 35th St., Meridian, Miss. 39301

In a recent paper, Browne & Bruder (1968), reduced *Succinea bakeri* Hubricht (1963) to the synonymy of *Succinea grosvenori* Lea because they: "were unable to draw distinctions either in measurements or form of shell, from some specimens of this fauna and forms described by Lea, Pilsbry, and others, as *S. grosvenori*." As a result, I feel that I should go into more detail as to my reasons for believing that the Pleistocene fossils of the loess which have been called *S. grosvenori* are not that species.

Pilsbry (1948) figured 12 shells as being *S. grosvenori* (fig. 444a-f, page 820); of these shells *a* and *d* are *S. greeri* Tryon. The shells *e* and *f* from Arizona do not look like *S. grosvenori*, and it is doubtful that it occurs so far west. These records, and that from Ogallala, Nebraska (fig. 444c) need to be anatomically verified. Thus, only the two shells *b*, the presumed paratypes from Lea, can be accepted as *S. grosvenori*. Pilsbry also reproduced Lea's figure (fig. 452i, page 833) which one could safely use. Pilsbry

records the species as far north as Great Slave Lake, Canada. That it occurs so far north is very doubtful. The most northern records for anatomically identified material are from Kansas, but there has been no recent work on the genus from farther north, so the northern limit of the species is unknown.

There are three species of *Succinea* found in the southern and central United States which, although they are quite distinct anatomically, cannot be identified by their shells with any real certainty. They are: *S. grosvenori*, *S. greeri*, and *S. indiana* (Pilsbry). These three species occur in similar habitats. They are all found on bare or sparsely weedy ground in sunny situations. I have never found any of them in the woods. Of the three, *S. grosvenori* prefers the wetter habitat. It is usually found in the vicinity of water, even near pools which remain for a few days after a shower. *S. greeri* occupies the driest habitat. I found it in Oklahoma crawling on a sheer, south-facing cliff after a shower. It is frequently found on loess banks with a southern exposure. Shells of *Catinella vermeta* (Say) and *C. texana* Hubricht have also been misidentified as *S. grosvenori*.

There are some shell differences between *S. grosvenori* and *S. bakeri* which, though not always reliable in the Succineidae where shell differences between species can be very small, do indicate a strong probability that they are distinct species. In *S. grosvenori* the start of the nuclear whorl is raised; in *S. bakeri* it is depressed. In *S. grosvenori* the whorls are usually somewhat shouldered; in *S. bakeri* they are not. Under the microscope the surface of *S. grosvenori* shows some spiral sculpture. None was seen on any of the shells of *S. bakeri* examined. The habitats of the two species are quite different. *S. grosvenori* is a sun-loving species of open ground, while *S. bakeri*, judging by its associated fauna, must have been a woodland species.

LITERATURE CITED

- Browne, Ruth G. & Pamela M. Bruder. 1968. Wisconsin molluscan faunas from Henderson County, Kentucky. Bull. Amer. Paleont. 54: 191-275.
- Hubricht, Leslie. 1963. Some Succineidae, with a new species. Nautilus 76: 135-138.
- Pilsbry, Henry A. 1948. Land mollusca of North America (north of Mexico). Acad. Nat. Sci. Philadelphia, Mon. 3, 2: 521-1113.

NONMARINE MOLLUSKS OF THE KATALLA REGION, ALASKA

By SAMUEL J. TUTHILL¹ and ROBERT L. JOHNSON²

In July of 1967, casual collections of terrestrial and freshwater gastropods were made along the coast of Katalla and Controller Bays (northeastern Gulf of Alaska, 60°00'10" N by 144°30'00" W, see U.S. Geological Survey maps, CORDOVA A-1, A-2, B-1, and B-2, scale 1:63360). The molluscan fauna of the coastal region is different from that of the adjacent Copper-Martin-Bering Rivers region. *Lymnaea palustris*, *Haplotrema sportella*, *Vespericola columbiana*, *Vertigo modesta*, *Succinea* cf. *S. rusticana*, var. *alaskana*, *Oxyloma* cf. *O. retusa*, *Deroceras laeve*, and *Euconulus fulvus alaskensis* were found at Katalla. Only *D. laeve* and *E. fulvus alaskensis* are part of the widely distributed molluscan fauna typical of the Copper-Martin-Bering Rivers region. The coastal region around Katalla, the Cordova region, and the course of the Copper River and Northwestern Railroad in the Copper River trench was the site of much American (non-native Alaskans) activity between 1898 and 1938 and to a lesser degree between 1938 and the present. The region east of the Copper River proper, the Martin River valley and all but the coastal part of the Bering River valley (only 12 miles from the village site of Katalla) has seldom been visited by non-Alaskan Americans. The molluscan fauna of the two regions is known from the investigations of Bickley (in press) in the Tasnuna Valley along the former right of way of the C.R.&NW RR; Tuthill (1963) which reported the results of investigations in the Martin River valley in 1962; Tuthill, Field, and Clayton (1968) which reported the nature and structure of the molluscan population of the Sherman and Sheridan Glacier valleys; investigations by the senior writer in 1963-5, 1967-8; and the studies reported here.

Differences in the molluscan fauna in the two regions show a strong association with the activity of man. We interpret these distributional phenomena to be the result of accidental introductions of *Lymnaea palustris*, *Haplotrema sportella* and *Vespericola columbiana* by non-Alaskan American developers during the first

¹Iowa Geological Survey, Iowa City, Iowa 52240

²Muskingum College, New Concord, Ohio.

third of the twentieth century. It is likely that *Vertigo modesta*, *V. ovata*, *Succinea rusticana* and *Oxyloma retusa* were also introduced by newly arriving Americans, but the general distribution of these taxa is such as to reduce our conviction from that we hold with respect to the three species mentioned above.

Table 1 shows the species composition of the faunas in the Katalla and Copper-Martin-Bering Rivers regions respectively. Table 2 shows the estimated population of *Lymnaea palustris* in a brackish tidal pool at Katalla.

Lymnaea palustris (Müller, 1774).

Taylor (1965, p. 598-599) has pointed out the fact that animals which had shells conforming to the conchological definition of this species were studied by Jackiewicz (1959) in Poland and found to constitute three distinct neontologic entities. The shells we collected at Katalla resemble the descriptions and figures of the following taxa in the indicated reports: *Galba palustris*, Baker (1911, p. 298-322), *Lymnaea palustris*, Hubendick (1951, p. 119-122) and *Stagnicola palustris*, La Rocque (1968, p. 443-446).

L. palustris was found only in brackish pools high on the beach east of the Katalla River. A series of interconnected pools, about 2 feet in maximum depth, parallel to the coast at the shoreward margin of the beach, about 1/2 mile from normal high sea strandline was found to contain an abundant, crowded population of the taxon. During periods of heavy rain and shortly following them, groundwater supplies a sufficient amount of water to these pools to effect flow in the interconnecting streams and water flows out of the system into an incipient back-beach lagoon and ultimately into the Katalla River estuary. It is conceivable that during heavy spring and fall storms and periods of very high tides that sea water is delivered directly to this part of the beach, but this was never observed by us. The salt content of the water is probably the result of leaching from the beach-sand shoreward of the system of pools. During periods of low or no rainfall the water level in these pools drops sharply. The entire population of one pool was collected. This pool had a water level which was 10 inches below the high strandline and the snails were concentrated in the upper 6 inches of the water. The few snails which were observed in the deeper water (the pool was 24 inches deep at its deepest point) were the largest individuals in the population.

Several specimens were observed crawling about on the moist ground and on grass stalks that grew at the pool edge. The area of beach in which the pools occur has been captured by grass, moss, and shrubs. Where sand bottoms occurred snails were scarce.

The junior writer collected the entire population of a pool which had a surface area of 90 sq. ft and an estimated volume of 160 cubic ft. At its highest stand the pool had had an area of 120 sq. ft and an estimated volume of 240 cubic ft. The structure and density of the population of snails was estimated from a 10 per cent sample of the 1900 individuals collected. There were 360 empty shells in the area collected and these were examined to determine whether mortality had been more prevalent at any one age class. A general living population density of 16 individuals/ft² of the plane at high strandline is not representative of the actual concentration of animals in the habitat. As mentioned above, only larger snails were common below 6 inches depth from the water surface at time of collection and the number of individuals above the water surface was also few. An estimated actual density of 23 individuals per sq. ft. of water surface and 36 individuals per cubic ft. of water is closer to the conditions which actually existed. Table 2 shows the distribution of *L. palustris* with number of whorls and length classes of 2 mm. A few shells were seen to have been drilled, presumably by a radula. Thus, although we did not observe it, cannibalism may possibly be a behavior common to much crowded *L. palustris*.

During six field seasons of collection in the region between Cordova, Chitina, and Katalla we have encountered this snail only at Cordova, the Tasnuna Valley, and at Katalla, all localities where white American activity has been intensive. This pattern of distribution inclines us to believe that the species has been accidentally introduced into the region.

Vertigo modesta (Say, 1824).

This tiny terrestrial snail was found on logs under stands of mature Sitka spruce growing on a raised beach ridge which is now about 35-40 ft. above the sea and about 1/2 mile inland. The Katalla region has been tectonically active during the past 14,000 radiocarbon years and as recently as 1964 was raised from 6 to 8 ft. during the Alaskan Earthquake. Thick accumulations of decaying alder leaves, spruce needles, and mosses cover the forest

floor. The snails were found only on logs which lay in the leaf litter. Twelve living snails were collected in one locality. Despite thorough search in similar habitats elsewhere in the region this species was not encountered again. Also of surprise to us was the absence of *Vertigo columbiana* which is an abundant and vigorous pioneer species in the recently deglaciated regions near the Sherman and Sheridan Glaciers and is found in large numbers on the stagnant, drift-insulated terminus of the Martin River Glacier.

Oxyloma cf. *O. retusa* (Lea, 1834).

The genera and species of the family Succineidae are differentiated on the morphology of their soft parts. Thus, assignment to genus and species is tentative, but the shells conform to the taxa indicated and as defined in Pilsbry (1948, p. 785-788). The three specimens of this taxon which we collected at Katalla were found on the moist margins of the pools described as the habitat of *L. palustris*. They were among specimens which we have assigned to *Succinea rusticana*. On an occasion previous to the time when we collected them, the senior writer observed much larger numbers of the family in these habitats. Presumable predation by birds, tracks of which were numerous, explains the reduction in the succinid population.

Succinea cf. *S. rusticana* var. *alaskana* Dall, 1905.

Four specimens of this taxon were collected with the *Oxyloma* around the pools mentioned above. The specimens from Katalla are smaller than the measurements given by Pilsbry (1948, p. 824-825). The number of whorls they contained suggests they were not yet fully grown when we collected them.

Haplotrema sportella (Gould, 1846).

This species was collected from Whale Island at Cape Martin, about 3 miles west of Katalla and in the village itself. At Whale Island (a tombolo-tied island since the uplift accompanying the Alaskan Earthquake of 1964) the snails were found, both live animals and shells, in the grass and leaf litter at the top of 30-50 foot-high sea cliffs. They were living in a zone which receives direct splash and much spray during the frequent violent storms of this part of the Gulf of Alaska. At Katalla they were found under the rotting logs and lumber of the delapidated buildings. Specimens of this species were collected from logs and lumber trash in the harbor of Cordova in 1963. Pilsbry (1946, p. 226) cites Vancouver

Table 1. Geographic distribution of nonmarine mollusks in south-central Alaska.

TAXA	KATALLA REGION	MARTIN- BERING RIVERS REGION	COPPER- TASNUNA RIVERS REGION	CORDOVA REGION
ANODONTA				
BERINGIANA		X		
SPHAERTIUM				
NITIDUM		X		
PISIDIUM				
COMPRESSUM		X		
PISIDIUM				
CASERTANUM			X	
PISIDIUM				
MILIUM			X	
VALVATA				
MERGELLA		X	X	X
LYMNAEA				
HUMILIS		X	X	X
LYMNAEA				
PALUSTRIS	X		X	X
MENETUS				
CALLIOGLYPTUS		X	X	X
GYRAULUS				
PARVUS		X	X	X
VERTIGO				
OVATA			X	
VERTIGO				
COLUMBIANA		X	X	X
VERTUGO				
MODESTA	X			
OXYLOMA				
RETUSA	X			
SUCCINEA				
RUSTICANA	X			
HAPLOTREMA				
SPORTELLA	X			X

Table 1 - continued

TAXA	KATALLA REGION	MARTIN- BERING RIVERS REGION	COPPER- TASNUNA RIVERS REGION	CORDOVA REGION
PUNCTUM cf.				
P. RANDOLPHI		X		
PROPHYSAON cf.				
P. ANDERSONI		X		
VITRINA				
ALASKANA		X		
EUCONULUS				
FULVUS	X	X		
DEROCERAS				
LAEVE	X	X		X
VESPARICOLA				
COLUMBIANA	X			X

Island as the most northern and westerly occurrence of this species. W. J. Eyerdam collected this species from Unalaska in June 1932 (ANSP #177891, 2 specimens), thus extending the range 38° of long. to the west and 3° of lat. to the north. Mr. Rae Baxter's collections from Cordova further extends the range of this species 51½° of latitude to the north. I suspect that search for this species and for *Vespericola* would prove successful in almost any coastal village site which was once a port of call of Seattle-based ships. We believe that this species was introduced.

Deroceras laeve (Müller, 1774).

Five living slugs were collected from dead logs and moss in the same area as that in which *Vertigo modesta* was found. Here, as elsewhere in the region, where the senior writer has been studying for the past 7 years, the slug occurred singly. In the interior of the coastal plain it is a common mollusk and we were surprised at its scarcity in the Katalla region. Suitable habitats were not wanting.

Vespericola columbiana (Lea, 1838).

Specimens were collected at Whale Island with *Haplotrema* and

at Palm Point (about $11\frac{1}{2}$ miles west of the village site) in dune grass mats. The specimens belong to the species in its strict sense and do not have the characteristics of the subspecies. Mr. Rae Baxter found this species with *Haplotrema* at Cordova. His collections constitute an extension of the known range of the species of about 1° of latitude to the north. We would expect to find this species in almost any coastal village or former village site which had been supplied by west coast-based steamers.

Euconulus fulvus alaskensis (Pilsbry, 1899).

Only three specimens of this species were found near Katalla. It was collected from logs in alder leaf litter as described in the previous discussion of *Deroceras laeve*. Its rarity is surprising because this taxon is a vigorous and abundant pioneer species of the inner coastal plain.

SUMMARY

Because they occur only at sites of current or former occupancy by non-Alaskan Americans who came to the Gulf of Alaska in relatively large numbers between 1898 and 1938, we believe that *Haplotrema sportella*, *Vesparicola columbiana*, and *Lymnaea palustris* are accidentally-introduced species. *Vertigo modesta*, *V. ovata*, *Succinea rusticana*, and *Oxyloma retusa* have general northern North American distributions which make us less convinced that they were accidentally introduced, but their distribution within the region is such that strong association exists between the activity of man and the colonization patterns of the snails.

ACKNOWLEDGMENTS

We are in the debt of other members of the 1967 field party for helping us collect mollusks, and for being patient with us when we delayed their progress. These persons were Dr. Leslie A. Sirkin, Adelphi University, Miss Catherine Smith and Mr. James K. Watson, Muskingum College. The National Science Foundation supported the research project of which this study was a collateral activity. We are grateful for their support in the form of Grant G. A. 869.

LITERATURE CITED

- Baker, F. C., 1911, The Lymnaeidae of North America, Recent and fossil: Chicago Acad. Sci., Spec. Pub'l. no. 3, 537 p., 57 pl.
Bickley, W. B., Jr., in press, The presences of gigantism in a molluscan fauna from south-central Alaska.
Hubendick, Bengt, 1951, Recent Lymnaeidae: Kungl. Svenska

Table 2. Estimated population of Lymnaea palustris in a 90 ft² (160 ft³) pool of brackish water on the beach east of the Katalla River estuary, Katalla, Alaska.

Number of whorls	Height									
	6mm		12mm		18mm		24mm			
4 -Alive	30	60	30	10	20					
-Dead		20	40	10						
4½ -Alive	10	60	120	260	130	70				
-Dead		10	60	80	10					
5 -Alive			70	70	330	90	40	30	10	
-Dead			20	40	10	10	10			
5½ -Alive						100	150	100	40	
-Dead				10		10				
6 -Alive						10		40		
6½ -Alive									20	
Totals										
Alive -	40	120	220	350	480	270	190	170	70	
Dead -	0	30	120	140	20	20	10	0	0	
Combined -	40	150	340	490	500	290	200	170	70	

Vetenskapsacademiens Handlingar, Fjärde Serien. Band 3, no. 1, 223 p., 5 pl.

Jackiewicz, Maria, 1959, Badania nad zmienoscia i stanowiskiem systematycznym *Galba palustris* O. F. Müller: Poznan, Prace Kom. Biol., v. 19, no. 3, 54 p.

La Rocque, Auréle, 1968, Pleistocene Mollusca of Ohio: Ohio Dept. Nat. Resources, Div. Geol. Survey Bull., 62, pt. 3, 197 p., 6 Pl.

Pilsbry, H. A., 1940, Land Mollusca of North America (north of Mexico): Philadelphia Acad. Nat. Sci., Mono., no. 3, v. 1, pt. 2, 430 p.

- , 1946, Land Mollusca of North America (north of Mexico): Philadelphia Acad. Nat. Sci., Mono., no. 3, v. 2, pt. 1, 520 p.
- , 1948, Land Mollusca of North America (north of Mexico): Philadelphia Acad. Nat. Sci., Mono., no. 3, v. 2, pt. 2, 592 p.
- Taylor, D. W., 1965, The study of Pleistocene nonmarine mollusks in North America: The Quarternary of the United States, Princeton, Princeton Univ. Press, p. 597-611.
- Tuthill, S. J., 1963, Preliminary report of the molluscan fauna of the Martin River Glacier and associated area: *Veliger*, v. 6, no. 2, p. 84-90, 1 map.
- Tuthill, S. J., W. O. Field, and Lee Clayton, 1968, Postearthquake studies at Sherman Glacier: in *The Great Alaska Earthquake of 1964 (Hydrology Volume)*, NAS Pub. 1603, Washington, National Academy of Sciences, p. 318-328.
-

ILLUSTRATIONS OF LAMARCK'S TYPES OF NORTH AMERICAN UNIONIDAE MOSTLY IN THE PARIS MUSEUM

By RICHARD I. JOHNSON
Museum of Comparative Zoology

Lamarck's private collection of shells was sold, after his death in 1829, to the Duc de Rivoli (Prince Masséna). It was later purchased by Baron B. Delessert, who in 1841, published a sumptuous iconography of the collection. This collection is now in the Geneva Museum. Much of the remaining material on which Lamarck based his names is in the Paris Museum (Muséum National d'Histoire Naturelle), including the collections of Valenciennes and J. B. L. d'Audebard, Baron de Férussac.

Most of these unionid types are illustrated here for the first time. I am grateful to Mr. H. Chevallier who prepared the photographs and to Dr. E. Fischer-Piette whose permission made their preparation possible.

Figured types

carinifera, Unio

Figure 4

1819, An. sans Vert., 6:74, No. 16 (Habite la rivière Hudson de l'état de New Yorck. Cabinet de M. Valenciennes). Holotype Paris Museum, length 73, height 50, width 32 mm. Is *Elliptio complanatus* (Lightfoot) 1786.

clava, Unio

Figure 9

1819, An. sans Vert., 6:74, No. 18 (Habite dans le lac Erié [erroneous] Michaud fils). Holotype Paris Museum, Length 75, height 45, width 33 mm.; also a paratype, described as var. b. (la

rivière de la Nouvelle Écosse [erroneous, does not occur in Nova Scotia]) length 55, height 33, width 26 mm. The type locality is, here, restricted, to the Ohio River, Cincinnati, Ohio. Discussed by Ortmann and Walker (1922:25). Is *Pleurobema clava* (Lamarck).

coarctata, Unio

Figure 5

1819, An. sans Vert., 6:73, No. 11 (Habite la rivière d'Hudson [New York], Cabinet de M. Valenciennes). Holotype Paris Museum, length 88, height 47, width 25 mm.; also a smaller paratype in the Geneva Museum. Is *Elliptio complanatus* (Lightfoot) 1786.

crassidens, Unio

Figure 2

1819, An. sans Vert., 6:71, No. 3 (Habite l'Amerique septentrionale, dans le Mississippi, l'Ohio, et plusieurs lacs). The specimen in the Paris Museum mentioned by Lamarck as var. b, is, here selected, lectotype, length 66, height 50, width 29 mm. The type locality is, here, restricted to the Ohio River, Cincinnati, Ohio.

A composite species, restricted by Lea (1834: 87 [199]) to var. b. (du lac Érié [erroneous]) on the basis of his identification of a paratype of it, in the Masséna collection, as *U. cuneatus* Barnes 1823. Lea also identified var. a, as *U. trapezoides* Lea 1831 = *Plectomerus dombeyana* Valenciennes 1827. Lamarck refers var. c to *U. crassus* Say, 1817, non Retzius, 1788 *Actionaias ligamentina* Lamarck 1819. Is *Elliptio crassidens* (Lamarck).

georgina, Unio

Figure 3

1819, An. sans Vert., 6:74, No. 17 (Habite le lac George [New York], Cabinet de M. Valenciennes). Holotype Paris Museum, length 59, width 29, height 15 mm. Is *Elliptio complanatus* (Lightfoot) 1786.

glabrata, Unio

1819, An. sans Vert., 6:75, No. 21 (Habite la rivière de l'Ohio [erroneous], Michaud). Holotype Paris Museum, length 70, height 32, width 20 mm. Is *Elliptio complanatus* (Lightfoot) 1786.

ligamentina, Unio

Figure 7

1819, An. sans Vert., 6:72, No. 7 (Habite la rivière de l'Ohio, Michaud). Holotype Paris Museum, length 73, height 50, width 32 mm. The type locality is, here, restricted to the Ohio River, Cincinnati, Ohio.

Lea examined the type (1834: 88[200]) and identified it as *U. crassus* Say 1817, non Retzius 1788. Lamarck's name was used consistently in the literature until 1922 when Ortmann and Walker (1922:47) declared the species to be unrecognizable from the description and used *carinata* Barnes 1823. Their action was unwarranted in view of Lea's identification and the availability of the type. Is *Actinonaias ligamentina* (Lamarck).

luteola, Unio

Figure 8

1819, Anim. sans Vert., 6:79, No. 40 (Habite la rivière Susquehanna [Pennsylvania and New York] et celle Mohancks [Mohawk, New York]. Holotype Paris Museum, length 69, height 38, width 24.5 mm. The type locality is here restricted to the Susquehanna River, Columbia, York Co., Pennsylvania.

Lea (1834:91[203]) identified the type as *U. siliquoides* Barnes 1823, claiming the localities to be in error. Ortmann and Walker (1922:61) declared the species to be unrecognizable from the description, but this, as pointed out above would not be germane if Lea's identification is correct. However it is difficult to determine the exact identity of the type, if it is from the Mohawk River, since as pointed out by Clarke and Berg, (1959:58-62, 68-70) *Lampsilis radiata radiata* (Gmelin) and the western *L. r. siliquioidea* Barnes co-mingle and intergrade completely in the lower St. Lawrence River drainage of New York.

The Mohawk River probably did not have *siliquioidea* in it before the completion of the Erie Canal, some years after *luteola* was described. Since only *L. r. radiata* occurs in the Susquehanna River, the locality is restricted to it. This makes further attempts (Wheeler, 1963:58) to resurrect this name unnecessary. Is *Lampsilis radiata radiata* (Gmelin, 1791).

naviformis, Unio

Figure 11

1819, An. sans Ver., 6:75, No. 20 (Habite la rivière de l'Ohio, Michaud fils). Holotype Paris Museum. Length 75, height 32, width 27 mm. Type locality is here restricted to the Ohio River, Cincinnati, Ohio. Is *Quadrula cylindrica* (Say) 1817.

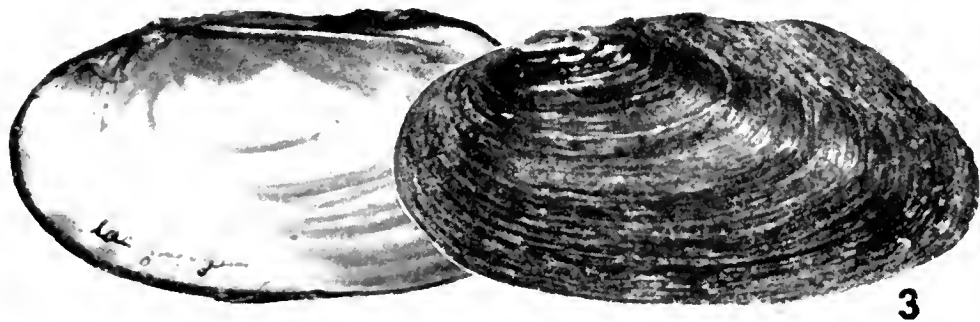
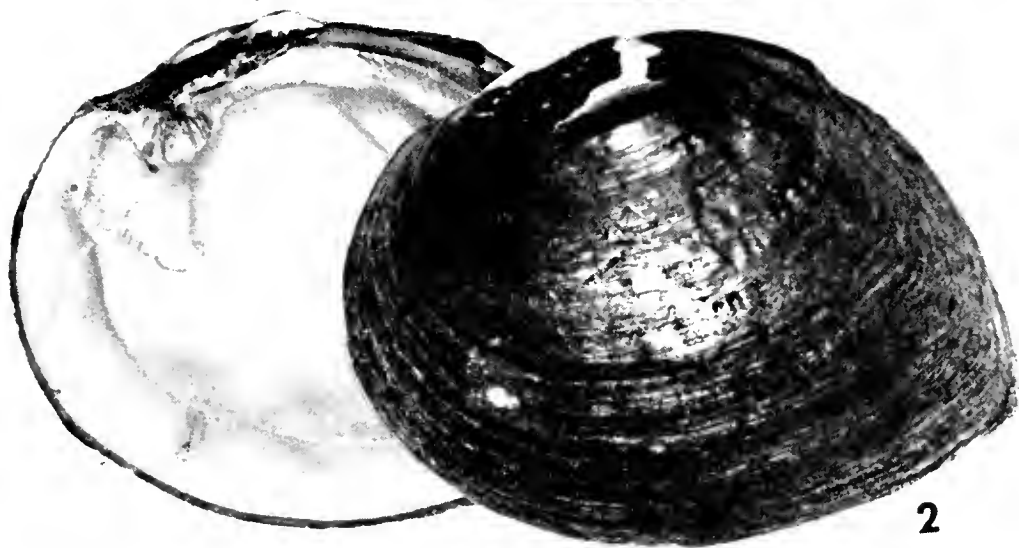
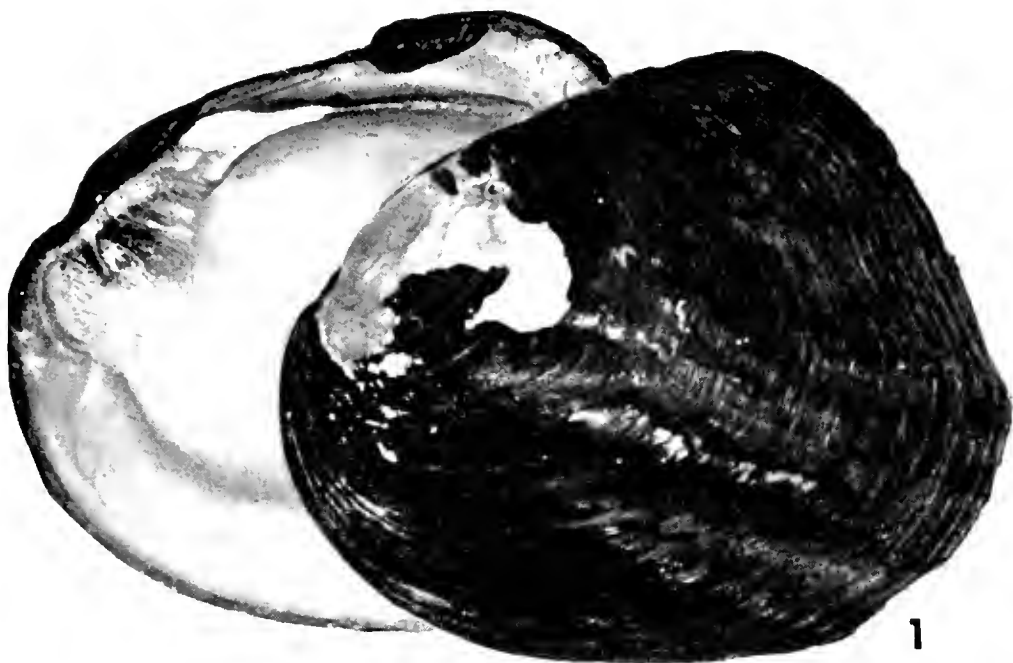
obliqua, Unio

Figure 14

1819, An. sans Vert., 6:72, No. 8 (Habite la rivière de l'Ohio, A. Michaud). Holotype Paris Museum [lost]. The specimen in the type collection from the Wabash [River, Indiana] from Le Sueur

Explanation to Figures

- Figure 1. *Unio variplicata* Lamarck. Holotype (nat. size).
- Figure 2. *Unio crassidens* Lamarck. Lectotype (nat. size).
- Figure 3. *Unio georgina* Lamarck. Holotype (nat. size).
- Figure 4. *Unio carinifera* Lamarck. Holotype (nat. size).
- Figure 5. *Unio coarctata* Lamarck. Holotype (nat. size).
- Figure 6. *Unio purpurascens* Lamarck. Lectotype (nat. size).
- Figure 7. *Unio glabrata* Lamarck. Holotype (nat. size).
- Figure 8. *Unio ligamentina* Lamarck. Holotype (nat. size).
- Figure 9. *Unio clava* Lamarck. Holotype (nat. size).
- Figure 10. *Unio rotundata* and *U. suborbiculata* Lamarck. Holotype United States National Museum 85760 right valve. (nat. size).
- Figure 11. *Unio luteola* Lamarck. Holotype (nat. size).
- Figure 12. *Unio retusa* Lamarck. Holotype (nat. size).
- Figure 13. *Unio recta* Lamarck. Holotype (nat. size).
- Figure 14. *Unio naviformis* Lamarck. Holotype (nat. size).





4



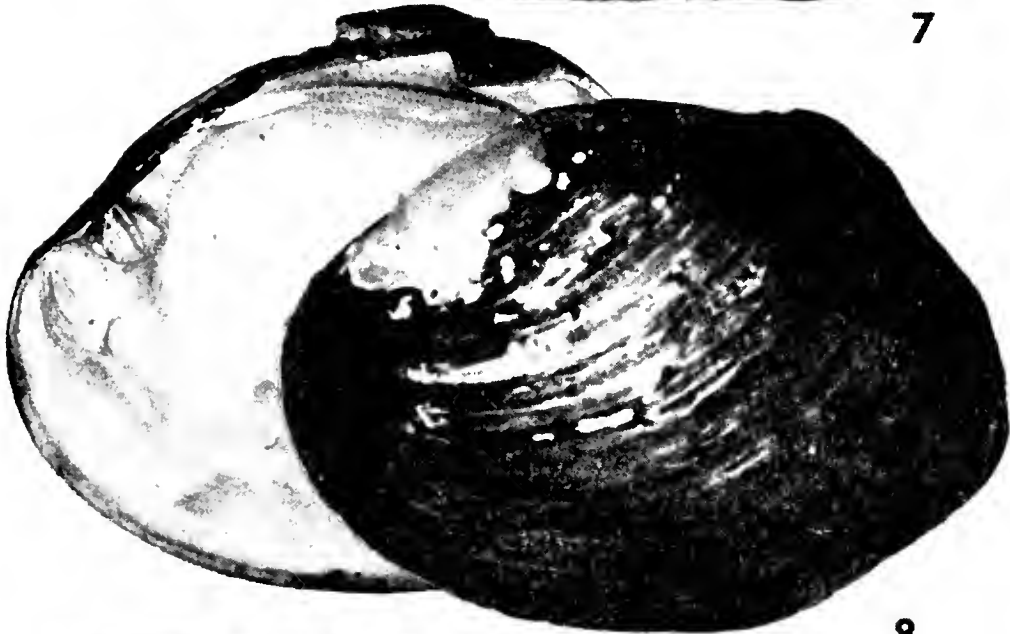
5



6



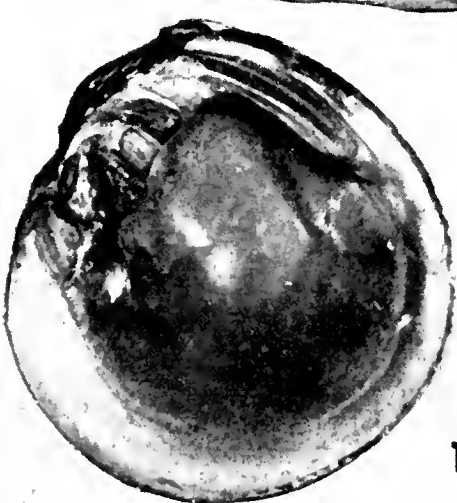
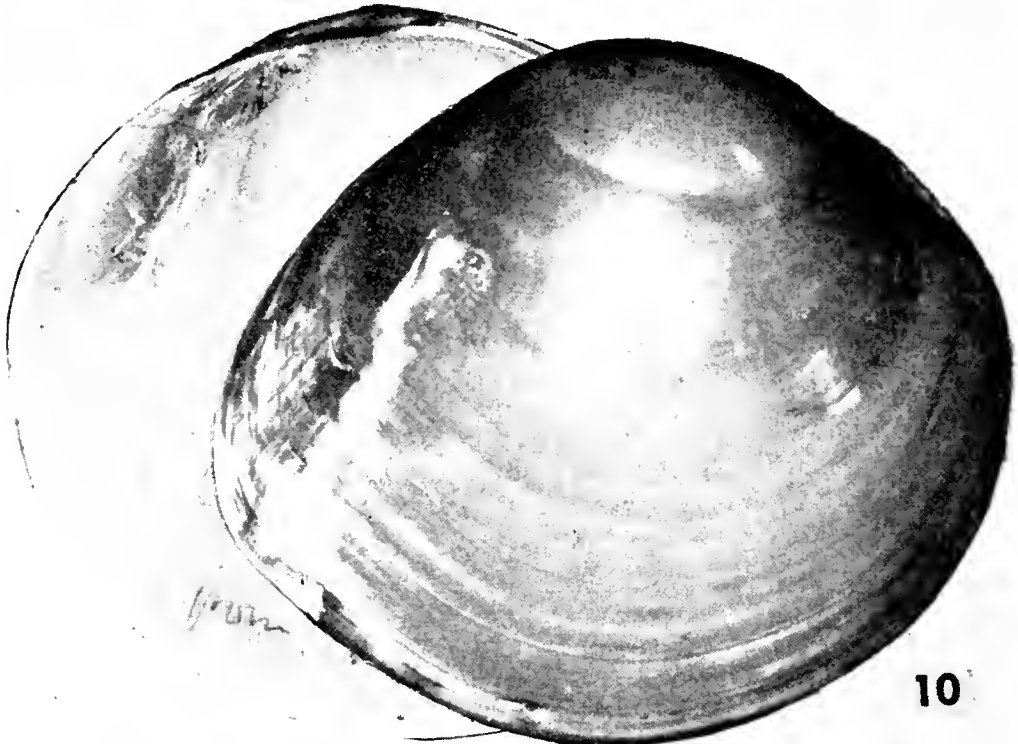
7



8



9





13



14

cannot be a primary type since Le Sueur was not in Indiana until 1826. Lea saw the collection in the Paris Museum in 1832 (1834; 88[200]) and identified it as *U. undatus* Barnes. Ortmann and Walker (1922:21) declared this species to be unrecognizable from the description, and since it is impossible to be sure if Lea saw the actual type, or only Le Sueur's specimen, the use of the next available taxon, *Obovaria cordata* Rafinesque, should be followed. Is possibly *Pleurobema cordatus* (Rafinesque) 1820.

purpurascens, Unio

Figure 6

1819, An. sans Vert., 6:73, No. 12 (Habite les rivières de New Yorck, Cabinet de M. Valenciennes). Since the type lot contains two species, var. c, Paris Museum is, here selected as the lectotype: length 92. height 48, width 28 mm. (du lac Champlain [New York] Le Sueur). Is *Elliptio complanatus* (Lightfoot) 1786.

rariplcata, Unio

Figure 1

1819, An. sans Vert., 6:71, No. 5 (Habite la rivière de l'Ohio, Michaud) presumed holotype Paris Museum, length 70, height 50, width 35 mm. Lamarck gives a length of 62 mm. The type locality is here restricted to the Ohio River, Cincinnati, Ohio. Is *Amblema plicata* (Say) 1817.

recta, Unio

Figure 13

1819, An. sans Vert., 6:74, No. 19 (Habite le lac Erié, Michaud). Holotype Paris Museum, length 100, height 41, width 31 mm. The original label has the additional data, "de la [vicin]ité de Niaga [Niagara Falls, New York]." Is *Lampsilis recta* (Lamarck).

retusa, Unio

Figure 12

1819, An. sans Vert., 6:72, No. 9 (Habite les rivières de la Nouvelle Ecosse [erroneous], A. Michaud). Presumed holotype Paris Museum, length 44, height 45, width 30 mm., Lamarck gives a length of 47 mm. A smaller paratype, length 40, height 42, width 31 mm. The type locality is here restricted to the Ohio River, Cincinnati, Ohio. Is *Obovaria retusa* (Lamarck).

rotundata, Unio

Figure 10

1819, An. sans Vert., 6:75, No. 24 (Habite . . . restricted to: Bayou Teche, St. Mary Parish, Louisiana, by Clench and Turner, 1956, 1:192). Type in Cabinet de M. Daubebard [Baron Férussac] et celui de M. Faujas [de Saint Fond], not in Paris Museum. Is *Glebula rotundata* (Lamarck). See under next item.

suborbiculata, Unio

Figure 10

1819, An. sans Vert., 6:81, No. 48 (Habite . . . les eaux douces des climats chauds? restricted to: Bayou Teche, St. Mary Parish, Louisiana, by Clench and Turner, 1956, 1:192, Cabinet de MM. Daubebard [Baron Férussac] et Faujas [de Saint Fond]). Not in Paris Museum. Measured holotype United States National Museum 85760 consists of a polished right valve, length 80, height 68.5, width 19 mm. Lea (1834:189 [201]) was presented this

specimen by Baron Férussac and believed it to be the individual cited by Lamarck. Férussac (Mag. de Zool., 5: cl. 5, Nos. 59, 60, p. 31, note 10) pointed out that Lamarck based his description of *Unio rotunda* and *suborbiculata* on the same specimen at two different times. There is an additional specimen of this species from Faujas in the Paris Museum, length 92, height 92, width of the valve 25 mm. Is *Glebula rotundata* (Lamarck).

LITERATURE CITED

- Clarke Jr., A. H. and C. O. Berg. 1959. The freshwater mussels of central New York. Agricultural Experiment Sta., Cornell Univ. Ithaca, New York. Mem. 367, pp. 1-79. 7 pls.
- Clench, W. J. and R. D. Turner. 1956. Freshwater Mollusks of Alabama, Georgia, and Florida from the Escambia to the Suwannee River. Bull. Florida State Mus., 1 (3):97-239, pls. 1-9.
- Delessert, B. 1841. Recueil de Coquilles Décrites par Lamarck dans son Historie Naturelle des Animaux sans Vertèbres et non encore figurées. 40 col. pls. with letterpress, folio, Paris.
- Johnson, R. I. 1952. A study of Lamarck's types of Unionidae and Mutelidae. Nautilus, 66:63-67, 90-95.
- Lamarck, J. B. P. de M. 1819. Historie Naturelle des Animaux sans Vertèbres, 6 (1):68-88. Paris.
- Lea, I. 1834. Observations on Lamarck's naiades. Trans. Amer. Philos. Soc., 6:86-94. Reprinted: 1834, Obs. Unio, 1:198-206.
- Ortmann, A. E. and B. Walker. 1922. On the nomenclature of certain North American naiades. Occ. Papers, Mus. Zool., Univ. Michigan, no. 122, pp. 1-75.
- Wheeler, M. J. 1963. Type of *Unio luteolus* Lamarck 1819. Nautilus, 77:58-61.

NOMENCLATORIAL NOTE: ARCTICIDAE VERSUS CYPRINIDAE (MOLLUSCA; BIVALVIA)

BY KENNETH J. BOSS

Museum of Comparative Zoology, Harvard University, Cambridge, Mass.

In a recent paper (Boss, 1968) I used the familial designation, Cyprinidae, for members of a molluscan family which reached the height of its diversity during the Jurassic and Cretaceous (Casey, 1952) and which today is represented by only one species, *Arctica islandica* (Linnaeus, 1767) (Lamy, 1920). The nomen Cyprinidae should not be used in malacological literature and my usage was in error.

Dr. Bruce B. Collette of the Bureau of Commercial Fisheries, Systematics Laboratory, Washington, D.C., called my attention to the existence of the family name Cyprinidae in Pisces for the

important and extremely large group of freshwater fishes (about 2,000 species) commonly referred to as minnows.

Nomenclatorial comments and a clarification of generic and familial usage of this name in malacology have been presented by Nicol (1951) and Bowden and Heppell (1968). For *Venus islandica* Linnaeus 1767, Lamarck (1818) applied the generic name *Cyprina* (type-species, *Venus islandica* Linnaeus, by subsequent designation, Children 1823, p. 312); earlier (1812) he had used the French vernacular "cyprine," which, of course, has no nomenclatorial status. Subsequently, Lamarck's *Cyprina* gained wide acceptance and the family-group name Cyprinidae, was introduced for this molluscan group by Geinitz (1846). Schumacher (1817) described *Arctica* with *A. vulgaris* Schumacher (= *Venus islandica* Linnaeus) as type-species by monotypy, but this generic name was preoccupied in Aves by *Arctica* Nozeman and Vosmaer, 1758. However, when the International Commission of Zoological Nomenclature voted to suppress the work of Nozeman and Vosmaer which was a Dutch translation of Moehring's pre-Linnaean work, *Avium Genera* (1752) (Hemming, 1944; 1954), the avian name *Arctica* became invalid and the junior homonym *Arctica* Schumacher 1817 was available for the mollusk and became the senior homonym of *Artica* Merrem 1819 (Aves).

The molluscan family-group name, Arctidae Newton 1891 is a junior synonym of Cyprinidae Geinitz 1846. In accordance with priority (Article 23 d), the senior synonym should be used. However, Geinitz's name is also a junior homonym of the piscean Cyprinidae Rafinesque 1815, so Arctidae Newton should be used for the molluscan taxon.

In malacological literature, Nicol (1951) pointed out that Arctidae and *Arctica* should be used, and he has been followed by Newell (1965) who outlined the nomenclature to be employed in the forthcoming and authoritative section on the Bivalvia for the Treatise of Invertebrate Paleontology. Some authors have maintained Arctidae but used Cyprinacea as a superfamilial appellation (Tebble, 1966) while others have employed Cyprinidae (e.g. Eberzin [in] Orlov, 1960; Zatsepin and Filatova, 1961; Ziegelmeier, 1962; Davitaschvili and Merklin, 1966). According to the Code, Article 40(a), "If a family-group name changed before 1961 because of such synonymy, has won general acceptance, it is

to be maintained in the interests of stability" (Nicol, 1951, pointed out the synonymy of *Cyprina* and *Arctica* and employed Arctidae in preference to the older Cyprinidae). Even though there might be some argument concerning the "general acceptance" of the nomen Arctidae, a strong case can be made for the use of Arctidae over the older Cyprinidae, primarily because the latter is homonymous with a taxon of fishes. Further, in accordance with Recommendation 40A, ". . . a family-group name . . . should be cited with its own author and date, followed by the date of the replaced name in parenthesis," the familial placement of *Arctica* should read Arctidae Newton 1891 (1846).

One further item concerns the nomenclature of this group of bivalves. In 1965, Newell proposed a new suborder Arctina for the five superfamilies Arctacea, Dreissenacea, Glossacea, Corbiculacea, and Veneracea. Alluding to the principle that ordinal-level names be derived from the root-word of their respective nomenclatorial types, Vokes (1967) emended Newell's name to Venerina. However, his emendation is, by extrapolation of the Code (Article 33 (2) (ii)), to be considered "unjustified" and is to be construed as a junior objective synonym of Arctina Newell 1965.

LITERATURE CITED

- Boss, K. J. 1968. New species of Vesicomidae from the Gulf of Darien, Caribbean Sea (Bivalvia; Mollusca). *Bull. Mar. Sci.*, 18 (3): 731-748, 28 figs.
- Bowden, J. and D. Heppell. 1968. Revised list of British mollusca. 2. Unionacea-Cardacea. *J. Conch.* 26: 237-272.
- Casey, R. 1952. Some genera and subgenera, mainly new, of Mesozoic heterodont lamellibranchs. *Proc. malac. Soc. London*, 29: 121-176, pls. 7-9.
- Children, J. G. 1823. Lamarck's Genera of Shells, translated from the French. *Quart. Jour. Sci.*, 14: 298-322.
- Davitaschvili, L. Sch. and R. L. Merklin. 1966. *Spravochnik po ekologii morskikh dvustvorok*. (Monograph on the ecology of marine bivalves). Moscow, 348 pp.
- Eberzin, A. G. [in] Orlov, Y. A., ed. 1960. *Osnovi Paleontologii. Molliuski, Dvustvorchatie*, Moscow, 300 pp., 44 pls.
- Geinitz, H. B. 1846. *Grundriss der Versteinerungskunde*. Dresden and Leipzig, 813 pp., 26 pls.
- Hemming, F. 1944. Opinions and declarations rendered by the International Commission on Zoological Nomenclature Opinion 5, The status of certain pre-Linnean names reprinted subsequent

- to 1757. London, 1, pt. 14:115-126.
- Hemming, 1954. [Ibid]. Opinion 241. Rejection for nomenclatorial purposes of Nozeman and Vosmaer, 1758. *Geslachten der Vogelen*, a Dutch translation of Moehring's pre-Linnaean work entitled *Avium Genera* published in 1752. London, 5, pt. 2 pp. 13-22.
- Lamarck, J. B. 1812. Extrait du Cours de Zoologie du Muséum d'Histoire Naturelle sur les Animaux sans Vertèbres. Paris.
- Lamarck, J. B. 1818. Histoire naturelle des animaux sans vertebres, Paris, 5, 612 pp.
- Lamy, E. Révision des Cypricardiacea et des Isocardiacea vivants du Museum d'Histoire naturelle de Paris. Jour de Conch., 64 (4):259-307. 1920.
- Linnaeus, C. 1767. Syst. Nat., ed. 12, 1, pt. 2, pp. 533-1327. Holmiae.
- Merrem, B. 1819. [in] Ersch. J. S. and J. G. Gruber. Allgemeine Encyclopädie Wissensch. und Künste. Leipzig, sect. 1, 2, p. 406.
- Moehring, Paul Heinrich Gerhard. 1752. Avium Genera. Bremae, 88 pp.
- Newell, N. D. 1965. Classification of the Bivalvia. Am. Mus. Novit., no. 2206, 25 pp., 3 figs.
- Newton, R. B. 1891. Systematic List . . . British Oligocene and Eocene Mollusca. London, British Museum (Natural History), 365 pp.
- Nicol, D. 1951. Recent species of the veneroid pelecypoda *Arctica*. Jour. Wash. Acad. Sci., 41 (3): 102-106.
- Nozeman, Cornelis and A. Vosmaer. 1758. Geslachten der Vogelen . . . Amsteldam: 97 pp., 2 pls.
- Rafinesque, C. S. 1815. Analyse de la Nature ou Tableau de l'Univers et des Corps Organisés. Palerme, 224 pp.
- Schumacher, C. F. 1817. Essai d'un nouveau système des habitations des vers testacés. Copenhagen, 287 pp., 22 pls.
- Smith, E. A. 1912. On the generic name to be applied to the *Venus islandica* Linnaeus. Proc. Malac. Soc. London, 10 (2): 105-106.
- Tebble, N. 1966. British bivalve seashells. London: British Museum (Natural History), 212 pp.
- Vokes, H. E. 1967. Genera of the Bivalvia, a systematic and bibliographic catalogue. Bull. Amer. Paleo., 51 (232): 112-394.
- Zatsepin, V. I. and Z. A. Filatova. 1961. The bivalve mollusc *Cyprina islandica* (L.), its geographic distribution and role in the communities of benthic fauna. Trans. Inst. Ocean., Acad. Sci. USSR, 46:201-216. (translation 74732, Dept. Northern Affairs and National Resources, Ottawa, Canada).
- Ziegelmeier, E. 1962. Die Muscheln (Bivalvia) der deutschen Meeresgebiete. Helgoländer wissen. Meeresuntersuch., 6 (1): 1-56, 14 pls.
-

MARINE MOLLUSKS OF PORT MOLLER BAY, ALASKA PENINSULA

By JAMES X. CORGAN

Austin Peay State University, Clarksville, Tennessee

Port Moller Bay and the confluent Herendeen Bay form the largest indentation in the Bering Coast of the Alaska Peninsula. Mollusks from this region were described and illustrated by Grewingk in 1850 (*vide* Dall, 1921). There is no other comprehensive report on Mollusca from the Bering shore of the Alaska Peninsula, although the distribution of one genus was recently described (Corgan, 1966).

During the summer of 1965, I collected in the Port Moller-Herendeen Bay area. Collections were made in the course of geologic mapping and time did not permit intensive sampling. Still, mollusca of the area are so little documented that presentation of a brief list seemed desirable.

Abundance estimates given below are apparent frequencies of beachworn, dead shells. They do not adequately reflect the abundance of living specimens which could not be evaluated. Wherever beach shells were common, a sediment sample was collected and examined for minute species. An *Odostomia* was the only microscopic mollusk observed.

Gastropods

Acmaea cribraria (Gould). Common.

Acmaea digitalis (Eschscholtz). Rare.

Acmaea pelta (Eschscholtz). Abundant.

Margarites (*Pupillaria*) *pupillus* (Gould). Common.

Littorina sitkana Philippi. Abundant.

Tectonatica clausa (Broderip and Sowerby). Rare.

Tachyrhynchus erosum (Couthouy). Common.

Thais lima (Gmelin). Abundant.

Odostomia (*Odostomia*) n. sp. Rare. Comparable to *O. cassandra* Bartsch, 1912.

Pelecypods

Mytilus edulis Linné. Abundant.

Pododesmus macroschismus (Deshayes). Rare. On washed up roots of kelp.

Clinocardium nuttalli (Conrad). Abundant.

Tellina lutea Wood. Rare.

Gastrana irus (Hanley). Common.

Macoma balthica (Linné). Common.

Macoma incongrua (von Martens). Abundant.

Macoma middendorfi Dall. Rare.
Siliqua alata (Dall) . Common.
Siliqua patula (Dixon) . Common.
Spisula polynyma (Stimpson) . Common.
Mya elegans (Eichwald) . Common.
Mya japonica Jay. Common.
Mya priapus Tilesius. Common.
Hiatella arctica (Linné) . Common.
Zirfaea pilsbryi Lowe. Rare.

LITERATURE CITED

- Corgan, J. X., 1966. *Mya* on the Alaska Peninsula: Nautilus, v. 80, p. 13-16.
Dall, W. H., 1921. Summary of the marine shell-bearing mollusks of the northwest coast of America . . . : U. S. Nat. Mus. Bull. 112: 1-217, pls. 1-22.
-

NOTES AND NEWS

THE BERMUDA BIOLOGICAL STATION is now under the direction of Dr. Wolfgang C. Sterrer, 29, graduate of the University of Vienna and specialist in interstitial faunas of marine sands. Dr. W. H. Sutcliffe, Jr., former Director, will now devote full time to research at the Bedford Institute of Oceanography, Halifax, Nova Scotia.

JOHANNES C. L. VAN DER RIET. 1920-1969. We regret to announce the untimely death of this ardent collector of Solomon Island mollusks, on July 27 at the age of 49 in Tervuren, Belgium.

GILBERT GRAU, 1906-1969—We regret to announce the death of our friend Gilbert Grau. He was born in Illinois, December 7, 1906, educated in music, and came to California many years ago, the past thirty years arranging music for many outstanding motion pictures and television. But we of the "Nautilus" world knew Gilbert Grau as a student of the Pectinidae of the Eastern Pacific. In 1959 he published this title in the Allan Hancock Pacific Series, vol. 23, plates 1-59, University of Southern California Press. He left his shell collection to the Smithsonian Institution. He was killed in an automobile accident on May 29, 1969—MRS. JOHN Q. BURCH, 1300 Mayfield Road, Apt. 61 L, Seal Beach, California 90740.

DR. GEORGE M. DAVIS will become Associate Curator of Malacology at the Academy of Natural Sciences of Philadelphia (Nineteenth and the Parkway, Philadelphia, Pa. 19103) in the spring or early summer of 1970. Dr. Robert Robertson is now Chairman of the Department. Other members of the Department now include Virginia Orr Maes, Research Associate, and Nancy Wilson Rulon, Scientific Assistant.

THE AMERICAN MALACOLOGICAL UNION's 35th annual meeting was held July 21-25, 1969 in Marinette, Wisconsin. 112 malacologists were the guests of the University of Wisconsin-Green Bay, the Marinette Area Chamber of Commerce and Margaret C. Teskey, long-time AMU secretary. President Joseph Rosewater presided over the meeting and introduced the following papers:

The molluscan fauna in North Carolina's Neuse River Estuary, **Hugh J. Porter**. Mollusca of a cedar bog in Champaign County, Ohio, **Eugene P. Keferl**. *Donax fossor*, a summer range extension of *Donax variabilis*, **Paul Chanley**. Western Atlantic *Donax*, **J. P. E. Morrison**. The Pleurocerid fauna of the Tennessee River, **Ralph M. Sinclair**. Egg Cases of *Nitidella ocellata* Gmelin and an *Anachis*, **Dorothy Raeihle**. Scandals in malacology, **Morris K. Jacobson**. Patterns of oxygen consumption of the freshwater Pulmonate snail, *Lymnaea palustris*, **David G. S. Wright**. Preliminary report on the distribution of land snails in Northern Missouri, **Charles D. Miles** and **Richard L. Reeder**. Some algae isolated from *Helisoma trivolvis* (Say), **Richard L. Reeder** and **Robert G. Anderson**. The Shells of Dioscorides of Anazarba, **Kenneth Jay Boss**. *Philophthalmus* sp. (Trematoda) in *Tarebia granifera* and *Melanoides tuberculatus* in South Texas, **Dr. Harold Murray** and **Deborah Haines**. Morphological-taxonomic notes on various freshwater Pulmonate snails, **Harold J. Walter**. (Read by title.) Problems in snail control in Hawaii, **Henry van der Schalie**. Problems and techniques in experimental work with bivalve larvae, **Ruth D. Turner**. Cabeza de Vaca, dealer in shells, **James X. Corgan**. Histological studies of the Nephridium and Pericardial lining of *Quadrula nodulosa* (Rafinesque), **Paul Robert Myers** and **Dorothea Franzen**. Late Pleistocene nonmarine mollusks from Lake Bretz, Lower Grand Coulee, Washington, **James J. Landye**. Some possible consequences of a sea-level Panama Canal, **Arthur H. Clarke, Jr.** Notes on *Valvata tricarinata* from Central Nebraska, **Carl W. Gugler**. Contributions to the biology of New England Nudibranch Molluscs, **M. Patricia Morse**. Malacology today, **D. S. Dundee**. Some Techniques in studies of freshwater snails, **Harold**

J. Walter. (Read by title.) Early American workers on the Naiades, William J. Clench. The earliest names for North American Naiades, J. P. E. Morrison. Some basic problems in Naiad taxonomy, David H. Stansbery. The freshwater mussels of the Canadian Interior Basin, Arthur H. Clarke, Jr. Where to find mussels in creek-size streams, Herbert Athearn. Effects of pollution on the Naiades of the Illinois River, William C. Starrett. Some research needs and methods for protecting Naiades from extinction, Marc J. Imlay. Seasonal variation in gonad activity in Unionid clams and its systematic significance, William H. Heard. Functional bilateral symmetry of the *Lampsilis* mantle: some problems, Louise R. Kraemer. Studies on the structure and ultrastructure of the glochidial stage of the Naiad *Actinonaias ligamentina* (Lamarck, 1819), Karen Heffelfinger. Life History of *Pleurobema cordatum* (Rafinesque, 1820), Paul Yokley. The life history of *Truncatella caribaeensis* 'Sowerby' Reeve, Landon T. Ross. A dual behavioral interpretation of a single environmental stimulus with freshwater clams, Marc J. Imlay. Speciation and distribution of Arctic wedge clams in the Western North Atlantic, John D. Davis. A revision of the land snail genus *Rabdotus* in Texas, W. L. Pratt. Special invertebrate staining techniques, Lucretia Buchanan. *Paramya subovata*, a commensal of the echiuroid *Thalassema hartmani*, Charles E. Jenner and Anne B. McCrary. Changes in the Naiad fauna of the Cumberland River at Cumberland Falls following impoundment, David H. Stansbery. The University of Arizona Marine Sciences Program, Albert R. Mead. Gonad development in the three-ridge naiad, *Amblema plicata* (Say, 1817), Carol B. Stein. Methods of subfamily recognition in Pacific Island endodontid land snails, Alan Solem. The American mussel industry—economic perspectives and ecological implications, John M. Bates.

The meeting followed the usual format: registration, papers mornings and afternoons, shell club night, the annual dinner. *Acella haldemani* was the featured mollusk; Harold Walter's beautiful line drawings of the living snail and of the shell adorned the program, and it obligingly turned up in limited quantity in the small lake combed by 42 who attended the final day's field trip.

The 1970 meeting will be held in Key West, Florida, and the following officers were elected to serve over the following year: President, Alan Solem; Vice President, David H. Stansbery; 2nd Vice President, G. Bruce Campbell; Secretary, Margaret C. Teskey; Treasurer, Mrs. H. B. Baker; Publications Editor, Morris K. Jacobson; Councillors at Large, Dorothea Franzen, Dorothy Raeihle, William E. Old, Jr., Gale G. Sphon, Jr.

THE EFFECT OF CHANGING pH ON THE UNIONIDAE.—Many articles have appeared in the literature concerned with the calciphile and calciphobe characteristics of mollusks. In central New York State, Clarke and Berg (1959) did not collect the larger fresh-water bivalves (Unionidae) in waters with an alkalinity of less than 47 ppm expressed as CaCO_3 . They stated that "Water hardness or alkalinity varies greatly in natural waters of central New York and exerts a strong influence on the distribution of unionids."

Although there seems little doubt that the amount of calcium present has profound effects on the vigor of unionid populations, I question the absence of particular species being directly due to lack of calcium.

On July 21, 1966, I collected mollusks in the headwaters of Alder Creek near the town of Highmarket, Lewis County, New York. Flowing over and between granite boulders, this stream did not seem a likely place for mollusks. The rocks were covered with diatomaceous algae and a few specimens of the vascular plant, *Myriophyllum* sp., were evident. The pH was 7.1; the total alkalinity 47 ppm expressed as CaCO_3 . A large population of *Anondonta cataracta* was present. There was absolutely no soft substrate for these animals to burrow in and many specimens were actually wedged between the rocks, ventral side up.

On the 9th of August, 1966, I collected in Genegantslet Creek, in Chenango County, near the town of Smithville Flats. This rather large stream appeared fairly productive with sparse beds of the aquatic vascular plants, *Elodea* sp. and *Potamogeton* sp. present. The pH was 6.9; the alkalinity 28 ppm expressed as CaCO_3 . Associated with the pulmonate snail, *Physa sayii*, were the unionids, *Alasmidonta undulata* and *Strophitus undulatus*.

In the dystrophic Panther Lake in Oswego County, on July 19, 1966, I found 7 species of aquatic gastropods and dense populations of *Elliptio complanata*. The pH at that date was 7.1; the total alkalinity 21 ppm expressed as CaCO_3 .

These few examples at least show that 4 species of unionids can and do occur in some soft waters. Because of the negligible buffering abilities of waters low in calcium, rapid changes in pH are practically always exhibited. It is probable that spasmodic fluctuations of pH values are detrimental to fresh-water mollusks. In

the three examples given the pH ranged only from 6.9 to 7.1. All of these environments are in relatively undisturbed watersheds in rather unpopulated areas. The local ecosystems are possibly stable enough so that pH values remain fairly constant even in these waters possessing poor buffering abilities.

These four species of Unionidae, representing two subfamilies, may not be affected by natural variations in water hardness as much as by the rapid changes in pH values usually associated with this phenomenon. I hope that someone is, or will study these relationships. Fresh-water bivalves are no longer present in many streams where "nontoxic" chemical wastes are disposed of. It seems probable that changes in pH may be at least partially responsible for their eradication.—WILLARD N. HARMAN.

LITERATURE CITED

Clarke, A. H., and C. O. Berg. 1959. The fresh-water mussels of central New York. Cornell Univ. Agr. Exp. Stat. Memor. 367:1-79.

OMALOGYRA ATOMUS (PHILIPPI) FROM MAINE.—Three specimens of the minute, uncommon gastropod, *Omalogyra atomus* (Philippi) were collected in tidepools at West Quoddy Head, near Lubec, Maine. They were found in samples of algae, along with the nest-building bivalve *Musculus discors* (L.) and the small gastropods, *Onoba aculeus* (Gould) and *Skeneopsis planorbis* (Fabricius). Although *O. atomus* has rarely been mentioned in American literature, it has been reported from Hampton Beach, New Hampshire, and Newport and Narragansett Pier, Rhode Island (Johnson, 1934. Proc. Boston Soc. Nat. Hist. 40 (1): 100). Whiteaves (1901. Catalogue of the Marine Invertebrata of Eastern Canada, Ottawa, 272 pp.), Lermond (1909. Catalogue of the Shells of Maine, 45 pp.), and Procter (1933. Mount Desert Region Survey, Part 5, Wistar Press, 402 pp.) make no reference to it. Its occurrence in Maine not only constitutes a new record for that state, but marks the first time specimens of this species have been collected in over sixty years. *O. atomus* is much more abundant in Europe and its functional morphology has been studied (Fretter and Graham, 1962. British Prosobranch Molluscs, Ray Society, 755 pp.). In addition, it has been reported from the east and west coasts of Greenland (Thorson, 1944. Medd. om Gronland 121

(13): 39, 148) and Iceland (Thorson, 1941. Zoology of Iceland 4 (60): 44), where it has also been found living in algae with *S. planorbis* and *O. aculeus*. Two of the three specimens collected have been deposited in the Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts.—Robert C. Bullock, Museum of Comparative Zoology, Massachusetts.

ODOSTOMIA CASSANDRA Bartsch.—Attempts to identify an *Odostomia* from southwestern Alaska led to examination of the type lot of *Odostomia cassandra* Bartsch, 1912. The conventional subgeneric placement of the species is incorrect. A lectotype has never been selected. The species was twice described as new. Authorship of the name, date of publication, and place of publication are currently confused. An abbreviated synonymy is as follows:

Odostomia cassandra Bartsch, 1912

1912. *O. (Evalea) cassandra* Bartsch, Proc. U. S. Nat. Mus. 42:285, pl. 38, fig. 5. (Skidegate, Queen Charlotte Islands, British Columbia).

1912. *O. (Evalea) cassandra* Bartsch, Bartsch, Proc. U. S. Nat. Mus. 42:341; 1921, Dall, Bull. 112 U. S. Nat. Mus.: 132.

1913. *O. (Evalea) cassandra* Dall and Bartsch, Victoria Mem. Mus. Bull. 1:142, pl. 10, fig. 7.

Illustrations and descriptions in Bartsch (1912) and Dall and Bartsch (1913) are virtually identical and are based on the same two cotypes: USNM 220120 and a then unnumbered specimen in the Geological Survey of Canada collection. Apparently this latter specimen, now number 1610 in the National Museum of Canada collection, was illustrated by Bartsch (1912). It is here selected as the lectotype of *O. cassandra* Bartsch, 1912. Bartsch is clearly author of the name, although authorship has sometimes been attributed to Dall and Bartsch, 1913 (e.g.: MacGinitie, 1959, p. 141).

Descriptions of *O. cassandra* stress an abundance of fine spiral striations. This is the basis for assignment to the subgenus *Evalea* A. Adams, 1860. As currently employed in North America, *Evalea* is almost a meaningless name but it does separate some spirally sculptured odostomids from other forms. *Odostomia cassandra* should not be placed with sculptured species. Although it appears sculptured, the surface is smooth. A sculptured appearance probably results from refraction within the thin, nearly transparent shell. In the terms of Dall and Bartsch (1909) the species is an

Odostomia (Odostomia).

I am indebted to Dr. Arthur H. Clarke, National Museum of Canada, and to Dr. Joseph Rosewater, U. S. National Museum, for access to specimens.—JAMES X. CORGAN, Austin Peay State University, Clarksville, Tennessee, 37040.

LITERATURE CITED

- Bartsch, P., 1912, Additions to the West American pyramidellid mollusk fauna with descriptions of new species. *Proc. U. S. Nat. Mus.* 42:269, pls. 35-38.
- Dall, W. H., and P. Bartsch, 1909, A monograph of West American pyramidellid mollusks. *U. S. Nat. Mus. Bull.* 68:1-258, pls. 1-30.
- , and —, 1913, New species of mollusks from the Atlantic and Pacific coasts of Canada. *Victoria Mem. Mus. Bull.* 1:139-146, pl. 10.
- Mac Ginitie, N., 1959, Marine Mollusca at Point Barrow, Alaska. *Proc. U. S. Nat. Mus.* 109:59-208, pls. 1-27.

MELANOIDES TUBERCULATA (MULLER) IN FLORIDA.—Through the kindness of Mrs. L. E. Crovo of Miami and Mr. A. K. Anders of Kissimmee we have received recently three lots of the introduced Oriental snail, *Melanoides tuberculata* (Müller). One lot, collected in September 1966 from Lake Osceola, Main Campus, University of Miami, Coral Gables and a second lot, collected in November 1968 in Greynolds Park, North Miami. The third lot, received from Mr. Anders, was collected in Hillsborough State Park, Hillsborough County. So far as I know these are the first records from Florida. Dr. Harold D. Murray has reported upon the occurrence of this species in San Antonio, Bexar County, and at New Braunfels, Comal County, Texas. (American Malacological Union Annual Report 1964, p. 15 and Annual Report 1965, p. 25).

The two lots from Miami probably represent two separate introductions as they appear to be rather distinctive populations. The series from Lake Osceola is proportionately a much stouter race than the specimens from Greynolds Park. The morphological differences between these two populations are well within the variations exhibited by any large geographic series. *M. tuberculata* is wide ranging, extending from north and east Africa east through Saudi Arabia, Iran, Pakistan, India and southern China, then southeast Asia into Indonesia as far east as Java and the Celebes.

—W. J. CLENCH

THE *PHYSA STRIATA* COMPLEX. Three different species of *P. striata* have been named. All three names have disappeared because of being synonyms or homonyms. Two of these names pertain to the Physidae and one to the Planorbidae. The following is a resumé of this complex.

PHYSIDAE

Physa heterostropha (Say)

Lymnaea heterostropha Say 1817, Nicholson's Encyclopedia, article on Conchology, Vol. 2, no pagination, pl. 1, fig. 6 (Delaware River).

Physa striata Menke 1828, Synopsis Methodica Molluscorum, Pyrmont, p. 79 (near Goshen, Massachusetts) [is *Physa heterostropha* (Say)].

Physa virgata Gould

Physa virgata Gould 1855, Proc. Boston Soc. Nat. Hist. 5:128 (River Gila [Arizona], and near San Diego [California]).

Physa striata Lea 1864, Proc. Acad. Nat. Sci., Philadelphia, p. 115 (Salt Lagoon, near Monterey, California).

Physa dorbigniana Lea 1866, Jour. Acad. Nat. Sci., Philadelphia 6:166, pl. 24, fig. 85; 1867, Observations on the Genus Unio 11:122, pl. 24, fig. 85. [New name for *Physa striata* Lea 1864, non *P. striata* d'Orbigny 1841]. [Is *Physa virgata* Gould, Pilsbry 1911, Proc. Acad. Nat. Sci., Philadelphia, p. 198].

PLANORBIDAE

Plesiophysa pilsbryi Aguayo

Physa striata d'Orbigny 1841, [in] de la Sagra, Histoire Physique, Politique et Naturelle de L'Ile de Cuba, Mollusques 1:192, pl. 13, fig. 14-16 (Martinique or Cuba [is Martinique]).

Plesiophysa pilsbryi Aguayo 1935, Mem Soc. Cubana Hist. Nat. 9:121. [New name for *Physa striata* d'Orbigny 1841, non *P. striata* Menke 1828].—W. J. CLENCH, Cambridge, Mass.

POLYDORA INFESTATION OF MERCENARIA MERCENARIA.—There have been very few reports of *Polydora* worm infestation of *Mercenaria mercenaria* probably because the quahog usually resides deep enough in the substratum to avoid attack by this marine polychaete. Landers (1967) did induce infestation of *M. mercenaria* by *Polydora ciliata* in the laboratory but only in the absence of substratum and on young specimens. Thus, it is significant to report a natural infestation of *M. mercenaria* brought to my attention by Mr. Clinton Andrews, resident supervisor at the Nantucket Research Center of the University of Massachusetts, Nantucket Island, Massachusetts.

During November 1967, scallop dredging operations were carried on in Nantucket Harbor. Several quahogs were also collected showing extensive shell damage, and some were subsequently sent to me by Mr. Andrews. External coloration indicated that the posterior third of each specimen had been exposed above the substratum. The valves had been exposed unevenly, one more than the other, and in each case the more exposed valve exhibited an extensive network (in the exposed part of the valve) of tubular excavations characteristic of *Polydora* infestation. However, I found no remains of this polychaete within the excavations. Apparently, the quahogs were usually not embedded vertically in the substratum but were tipped to one side, the infestation occurring only on the upper side.

Quahogs are usually buried sufficiently to escape a scallop dredge, but presumably recent storms had caused substratum dislocation in the shallow harbor, and some quahogs were thus exposed. All specimens of *M. mercenaria* recovered were of good size suggesting that larger specimens may be less mobile and much slower in re-entering the substratum. Thus exposed, they were infested by *Polydora* sp.

Infestation perforations penetrated the inner surface of one specimen within the posterior adductor muscle scar, but no extensive damage appeared to have resulted. The specimens were alive when collected. JOHN D. DAVIS, Smith College, Northampton, Massachusetts.

REFERENCE CITED

- Landers, W. S. 1967. Infestation of the hard clam, *Mercenaria mercenaria* by the boring polychaete worm, *Polydora ciliata*. Proc. Nat. Shellfisheries Assoc. 57:63-66.

ACHATINA FULICA INVADES FLORIDA—In 1966, a boy brought home from Hawaii specimens of this Giant African Snail in his luggage as pets. They and their offspring were released in the neighborhood gardens of North Miami, and now, by September 1969, have become a horticultural nuisance in a 13-square block area surrounding North Miami Avenue and N.W. 125th St. The Florida State Agricultural Control officials are attempting to confine and eliminate the infestation.—R. Tucker Abbott

JOHNSONIA: VOLUME 1

Long out of print, this useful monograph series on Western Atlantic Conidae, Muricidae, Strombidae, Cardiidae, etc., is now once again available. Reproduced in its original size, original paper, and beautifully soft-bound, it may be obtained for only \$15.00 (postage and packing free) from W. AND R. McCAULEY, 1919 Sandy Hill Road, Apt. C-12, Norristown, Pa. 19401. If you also wish vols. 2, 3 and 4, write: DR. W. J. CLENCH, Museum of Comparative Zoölogy, Cambridge, Mass. 02138, U.S.A.

PUBLICATIONS RECEIVED

- Powell, A. W. Baden. Sept. 9, 1969. The Subfamily Turriculinae, Part 2 of The Family Turridae in the Indo-Pacific. Indo-Pacific Mollusca, vol. 2, no. 10, pp. 203-416, 136 pls., 1 in color. \$10.55. This journal is now published by the Delaware Museum of Natural History, Greenville, Delaware 19807.
- Dall, William Healey, 1845-1927. The Zoological Taxa of William Healey Dall. By K. J. Boss, Joseph Rosewater and Florence A. Ruhoff. Bull. 287, U.S. National Museum, 427 pp. 1968. \$2.50 by writing Superintendent of Documents, U.S. Gov. Printing Office, Wash., D.C. 20402. An extremely useful and much needed bibliographic work that is well done.
- Fretter, Vera (editor). 1968. Studies in the Structure, Physiology and Ecology of Molluscs. Symposia of the Zool. Soc. London. Academic Press, N. Y. 377 pp., illus. Contains 18 excellent research articles on marine, land and fresh-water mollusks, including "A review of the bivalved gastropods and a discussion of evolution within the Sacoglossa" by E. Alison Kay; "The biology of interstitial [marine sand] Mollusca" by B. Swedmark; "The Feeding Mechanism and behaviour of the opisthobranch *Melibe leonina*" by Anne Hurst; "The burrowing activities of bivalves" by E. R. Trueman; and "Habitat distribution of Solomon Island land Mollusca" by John F. Peake.

Nowell-Usticke, G. W. 1969. A Supplementary Listing of New Shells. 32 pp., 6 pls. Privately printed. Price unknown.

This booklet was intended to be a supplement to Mr. Usticke's somewhat controversial publication on the shells of St. Croix (1959). It is actually a summary of the author's contribution to West Indian marine conchology and represents a serious problem for those interested in the systematics of Caribbean mollusks. Most taxonomists who describe new taxa make careful literature surveys, study comparative material, and often try to understand the mechanisms of speciation. Mr. Usticke, on the contrary, introduces names for atypical specimens and for species which he does not understand. In this present copyrighted "small listing," seventy species, subspecies, forms, and varieties are described as new, including eleven "new" *Conus* which he had previously described (Nowell-Usticke, 1968; see review by Dr. R. Tucker Abbott, 1969, *Nautilus* 82: 147).

It is unfortunate that Mr. Usticke did not consult authorities on West Indian marine mollusks, for if he had, many of the numerous misspellings, taxonomic errors, homonyms and synonyms which he has created could have been avoided. The following examples serve to illustrate some of the errors and inconsistencies which characterize this work: *Mitra pallida* Usticke, 1959 [non A. Adams, 1851; non Pease, 1860] is listed (p. 19) as a subspecies of *M. nodulosa*, yet the description begins "May be *granulosa* Lamarck;" *Vasum aldridgei*, n. sp. (p. 18), is the muricid, *Muricopsis philippiana* Dall; Shuster and Bode (1961. *Nautilus* 75: 1-7) discussed the variation of *Vasum globulus nuttingi* Henderson, yet Mr. Usticke has described an additional subspecies (p. 19) from the same general locality; *Anachis multicosta*, n. sp. is introduced (p. 16) with the comment "Possibly *pulchella* Kiener;" the author of *Fenimorea ustickei* Hayes is listed as "Hayes-Usticke," leading one to wonder who actually described the species; *Triphora novem* is inadequately described (p. 12) as new, with reference made to the figure of the lectotype of *T. intermedia* (C. B. Adams); *Ischnochiton dubium*, n. sp. (p. 7), appears to be *I. bermudensis* Dall and Bartsch; *Brachidontes exustus* var. *roseus*, n. s. sp. [sic] and *B. pseudorecurvus*, n. sp. (p. 5), are both examples of the common Caribbean *B. cubitus* (Say). *Ringiculina* [*Ringicula* on pl. VI] *cruzensis* new sp. (p. 30) has a single denticle

on the outer lip; to be the shell of a cephalaspid opisthobranch it would need to lack this; many cephalaspids have columellar folds, which Usticke's larval shell lacks; his new species is a sinusigera of some prosobranch. Mr. Usticke continually confuses the terms "species," "subspecies," "form," and "variety."

Abbott (1959, *Nautilus* 82: 147) raised the question about the validity of this type of publication. Except for the obvious violation of Article 15 of the International Code of Zoological Nomenclature which eliminates the availability of approximately one third of the proposed new names, Mr. Usticke has not directly violated any other rule. He does, however, display his ignorance or rejection of the principles of the Code by violating a majority of the applicable Recommendations. Most important among the latter are his failure to designate type specimens, deposit them in an institution, compare his new taxa with related ones, give adequate data concerning the types, and follow recommended spelling procedures. It appears that the neglect of so many recommendations and the pronounced unscientific attitude of this conchologist are possible grounds for declaring all three of his booklets invalid. Works of this sort not only promote instability of malacological nomenclature, but do much to hinder its progress.

The photographs are for the most part, good and, in some cases, the only means of interpreting the inadequate descriptions.

LITERATURE CITED

Nowell-Usticke, G. W. 1959. A Check List of the Marine Shells of St. Croix. 90 pp., 4 pls. Lane Press, Burlington.

Nowell-Usticke, G. W. 1968. Caribbean Cones from St. Croix and the Lesser Antilles. 31 pp., 4 pls. Livingston Publ. Co., Narberth, Pa.

—Robert C. Bullock, Museum of Comparative Zoology, Cambridge, Mass.

Dance, S. Peter. 1968. Rare Shells. Univ. California Press, Berkeley, 128 pp., 24 pls. in color. \$17.00 Foreword by R. Tucker Abbott. Good photographs and interesting historical account of 50 presently or formerly rare shells are included.

Something New in Conchology

**A professional recording of the pronunciations of 1,200
scientific species and generic names of
"SEASHELLS OF NORTH AMERICA"**

also how to enunciate—authors' names, family names, and
dozens of technical names, such as
apophysis, conchiolin, eolis, and
veliger.

Produced and published by R. TUCKER ABBOTT
Sponsored by the Delaware Museum of Natural History
Greenville, Delaware 19807

This is a high-fidelity, long-playing (33 $\frac{1}{3}$ RPM) recording of the names and terms found in Dr. Abbott's new and popular book, *Seashells of North America* (Golden Press, N.Y.). Born in Boston, bred in Canada and a graduate of Harvard College, Dr. Abbott has blended the customary pronunciations of the top professional malacologists in the United States and Canada that set a high standard of acceptability. All names and terms are printed on the record jacket. A unique and long-lasting aid to your study of shells and biology, for only \$4.95 (postage paid).

Obtainable from your favorite shell dealer

WILLIAM H. WEEKS SHELL COLLECTION: New price lists of this famous collection, with full scientific data, are in preparation. Many new additions of fine and rare species are also included. To obtain free copies write:

GEORGE E. JACOBS, 853 Riverside Drive, New York 32, N. Y.

WORLD WIDE SPECIMEN SHELLS for sale. New 1969 Price List on request. "Illustrated Catalog of Popular Marginella Species" now available also, 117 species shown with full data and values listed with cover in color. Price \$2.00.

PHILLIP W. CLOVER
Box 33, Div. 32
FPO, New York 09540

THE
NAUTILUS

THE PILSBRY QUARTERLY
DEVOTED TO THE INTERESTS OF CONCHOLOGISTS

EDITORS AND PUBLISHERS

HORACE BURRINGTON BAKER, 11 Cheltenham Road, Havertown, Pa.
(Emeritus Professor of Zoology, University of Pennsylvania)

R. TUCKER ABBOTT, duPont Chair of Malacology
Delaware Museum of Natural History, Greenville, Del. 19807

CHARLES B. WURTZ, *Biology Department*
La Salle College, Philadelphia, Pa. 19141

CONTENTS

Mode of life of <i>Conocardium</i> , a Paleozoic pelecypod. By David Nicol	77
The distribution of the nudibranch, <i>Doris verrucosa</i> Linné, in the northwest Atlantic. By David R. Franz	80
<i>Cymatium boschi</i> , a new species from the Arabian Sea. By R. T. Abbott and Hal Lewis	86
<i>Aspella myrakeenae</i> , new species from Western Mexico. By W. K. Emerson and A. D'Attilio	88
New Mitridae and Volutomitridae. By Walter O. Cernohorsky	95
Rediscovery of the limpet, <i>Acroloxus coloradensis</i> , in Colorado. By George W. Bryce, Jr.	105
Longevity in <i>Ashmunella</i> , <i>Monadenia</i> and <i>Sonorella</i> . By Munroe L. Walton	109
Notes and news	112
Publications received ...	iii

\$4.25 per year (\$4.75 to Foreign Countries) \$1.25 a copy.

Mrs. Horace B. Baker, Business Manager
11 Cheltenham Road, Havertown, Pennsylvania 19083

Second-Class Postage paid at Spring House, Pa.

NAUTILUS:

A Quarterly Journal devoted to the study of Mollusks, edited and published by HORACE B. BAKER, CHARLES B. WURTZ and R. TUCKER ABBOTT.

AUTHORS PLEASE NOTE:

Matter for publication should be sent to the acting editor, Dr. R. Tucker Abbott, Delaware Museum of Natural History, Greenville, Delaware 19807. *Manuscripts should be typewritten and DOUBLE SPACED throughout, including titles, footnotes and bibliographies. Please give reprint order, if any.*

Please correct and return galley proof (submitted without manuscript) quickly. Changes from manuscript, as edited, may be disregarded.

Authors are charged for engraving blocks of plates and/or figures at cost. Minimum charge for each block is \$3.00.

REPRINTS are furnished at printer's rates. ORDERS SHOULD BE WRITTEN ON OR ATTACHED TO FIRST PAGE OF MANUSCRIPT. REPRINTS are shipped, with invoices, by PONY PRINTING, 4 Cloverdale Avenue, Upper Darby, Pennsylvania 19082. PURCHASE ORDERS, when required, and shipping instructions, *MUST* accompany original orders. Extra clerical or bookkeeping work because of delayed receipt of purchase orders will be charged for accordingly:

TEXT PAPER	2 pp.	4 pp.	8 pp.	12 pp.	16 pp.
First, 100 copies	3.40	6.35	13.25	18.70	23.95
Additional 100	.65	1.40	4.30	5.50	6.70
PLATE PAPER					
First 100 copies	3.70	6.90	14.45	20.45	26.25
Additional 100	.90	1.95	5.45	7.25	9.00

Prices subject to change without notice. Postage extra.

THE NAUTILUS is an official organ of the American Malacological Union. Information regarding membership in the Union may be obtained from Mrs. Margaret C. Tesky, Secretary, Route 2, Box 318, Marinette, Wisconsin 54143.

BACK ISSUES: Vols. 3-70, if available, can be obtained from KRAUS PERIODICALS, INC., 16 East 46th Street, New York, N. Y. 10017. Vols. 71 to date are available from the NAUTILUS, 11 Cheltenham Road, Havertown, Pennsylvania 19083, and vary in price.

THE NAUTILUS

Vol. 83

January, 1970

No. 3

MODE OF LIFE OF CONOCARDIUM, A PALEOZOIC PELECYPOD

By DAVID NICOL

Department of Geology, University of Florida
Gainesville, Florida 32601

One of the most extraordinary pelecypods that ever lived was a small family of bivalves, the Conocardiidae, typified by *Conocardium*. Vokes (1967), in his catalogue of pelecypod genera, places this group in a separate order (Conocardioida) under the subclass Cryptodonta. The only living family belonging to the Cryptodonta, according to Vokes, is the Solemyidae. This allocation of the conocardiids, as Vokes admits, can be considered only an educated guess, and a few paleontologists have gone so far as to doubt that the conocardiids were pelecypods or even molluscs. It is my contention that these bivalved animals were molluscs and very likely pelecypods. Therefore, I am interpreting the life habit of the conocardiids on the assumption that they were aberrant pelecypods.

The conocardiids were among the most ancient basic stocks of pelecypods, appearing in the Early Ordovician. The heyday of the conocardiids seems to have been the Devonian and Mississippian, although they were still common in many Pennsylvanian faunas. There is a clear indication of further decline of this group in Permian marine faunas, and the species of this geologic period are commonly of small size. There is considerable doubt that the conocardiids survived to the very end of the Permian, and so all reports of occurrence of conocardiids in Triassic rocks are false.

To begin with, the orientation (as to which is anterior and which is posterior), has long been in dispute, with opinion rather evenly divided. There are two gapes in the shell, one at the end of a tubular process and a much larger gape near the other end of the shell. The tubular process varies greatly in length from almost nonexistent to longer than the remainder of the shell. In appearance it reminds one of the rostrum or tubular process of *Cuspidaria*. I believe that the tubular process had to be at the posterior end and probably contained the exhalant and possibly the inhalant

siphons. The larger gape, then, would be for the foot and is located either on the ventral margin in about the same position as in *Arca, sensu stricto*, or somewhat farther anteriorly near the antero-ventral margin (compare figs. 1 and 2). In size and shape but not in position, the gape in *Conocardium* is much like that of *Tridacna crocea* Lamarck (fig. 5). The ornamentation of *Conocardium* also resembles that of some species of *Arca, sensu stricto*, (figs. 3 and 4).

To further complicate matters, some (but most certainly not all) species of *Conocardium* had a shelly structure on the posterior side of the valves that La Rocque (1950, p. 317) called a hood. The hood was a scooplike shelly extension that began at about the middle of the exterior of the valves and extended posteriorly. The possible function of this structure is unknown to me.

Another puzzling feature noticed by Chronic (1953, p. 154, in Newell, Chronic, and Roberts) in a species of Permian *Conocardium* from Peru is that a part of the valve margins appears to be fused. I noticed this same condition in some well preserved specimens from the Pennsylvanian of Texas. This would probably make the animals nearly or completely immobile in the adult stage because the gape for the foot near the anterior end is not large enough to permit much movement. Most fossil pelecypods are found with the valves separated, but most conocardiids are found with the valves still joined, and this also adds some credence to the observation that the valve margins may have been fused.

I believe that *Conocardium* was attached by a stout short byssus to the substrate; it was an epifaunal, not an infaunal pelecypod. In most species of *Conocardium*, the size, shape, and position of the gape is similar to *Arca, sensu stricto*. Most species of *Conocardium* probably lived in an attached position like *Arca* with beaks and dorsal side up, the valves perpendicular to the substrate. In some species of *Conocardium*, the byssal gape is farther forward in an antero-ventral position so that the animal would have the posterior side somewhat tilted upward in the attached position. Hind (1900, pp. 452-453) assumed that the large gape in the valves of *Conocardium* was for the passage of a stout byssus.

My reasons for believing that *Conocardium* was byssally attached are as follows: *Conocardium* had a very thick shell; modern burrowers and borers have thin, or relatively thin, shells. The

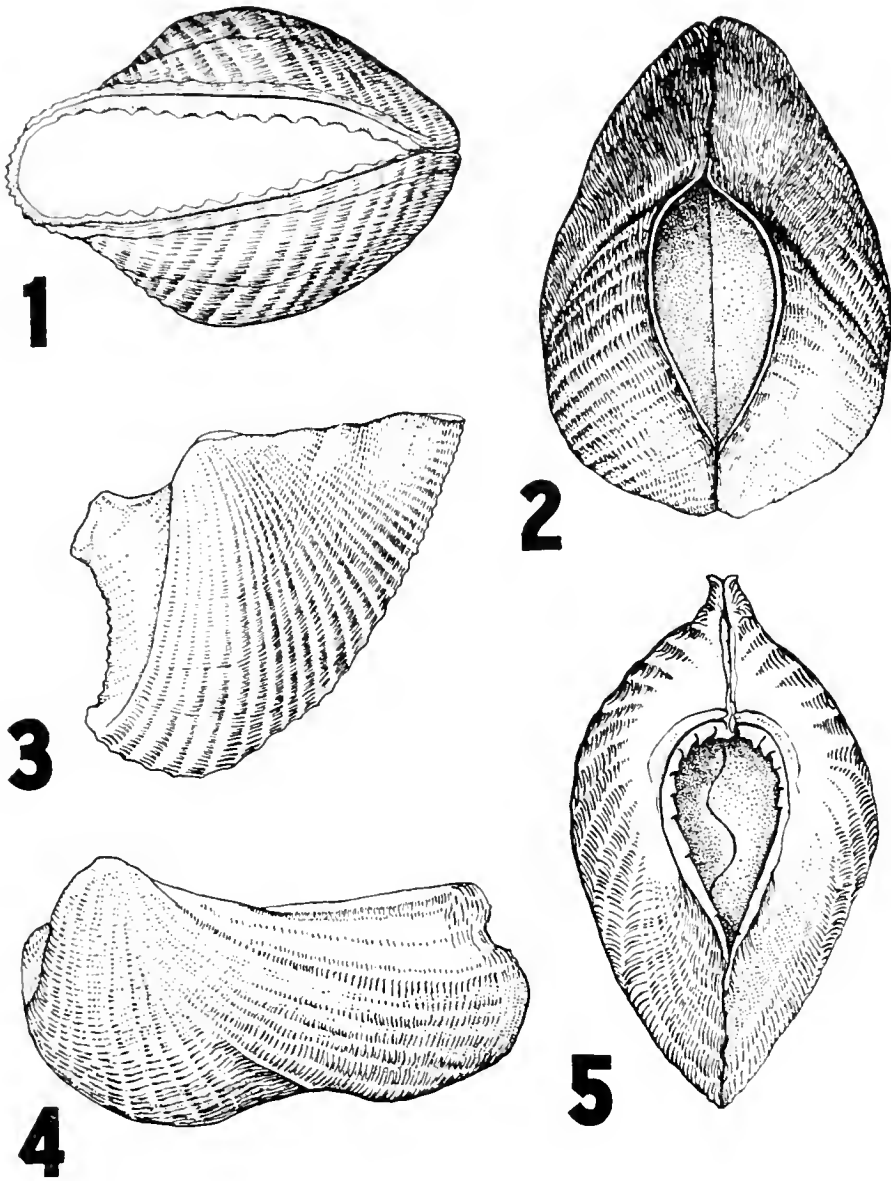


Fig. 1. *Conocardium* sp., ventral view of both halves showing the byssal gape. Fig. 2. *Arca ventricosa* Lamarck, ventral view of both valves showing the byssal gape. Fig. 3. *Conocardium* sp., exterior view of a right valve. Fig. 4. *Arca ventricosa* Lamarck, exterior view of a left valve. Fig. 5. *Tridacna crocea* Lamarck, ventral view of both valves showing the byssal gape.

valves of *Conocardium* are gibbous or highly convex. Living pelecypods of great convexity are poor and shallow burrowers, if they burrow at all. The anterior side of most species of *Conocardium* is strongly alate or winged. The anterior margin comes to a point at the antero-dorsal border. Many byssally attached forms have an anterior wing-like projection, as for example *Pteria*; but the anterior side of burrowers and borers is commonly gently rounded

or even truncated. If the valves were fused in the adult stage of some species, how could burrowing or boring be accomplished easily? Moreover, the gape is not as large or round as it is in modern pholads, which use a sucker-like action of the large foot to aid in boring.

The only weakness to my argument that I can see is why did these animals have a posterior tube or rostrum? There is no adaptive significance to this structure for a byssally attached pelecypod. Perhaps there was no adaptive significance to the posterior tube, but we know almost nothing about the anatomy of the animal. Furthermore, what is the adaptive significance for the hood which occurs in some species of conocardiids? The difficulty in interpreting the mode of life of *Conocardium* is that even its external form is so unlike any other pelecypod, living or extinct, that comparisons are exceedingly difficult to make.

I am convinced, however, that on the basis of the overall appearance of the shell, *Conocardium* was a byssally-attached epifaunal pelecypod. The likelihood that *Conocardium* was an infaunal burrower or borer is indeed remote.

I am indebted to Miss Marsha E. Jessup of the U. S. National Museum for making the drawings for this paper.

LITERATURE CITED

- Hind, W., 1900. A monograph of the British Carboniferous Lamellibranchiata. Part V. Coelonotidae, Solenomyidae, Conocardiidae, Cardiidae: Palaeontographical Soc. London, Vol. for 1900, pp. 361-436, pls. XL-LIV.
- La Rocque, A., 1950. Pre-Traverse Devonian pelecypods of Michigan: Mus. Paleo., Univ. Michigan, 7 (10): pp. 271-366.
- Newell, N. D., J. Chronic, and T. G. Roberts, 1953. Upper Paleozoic of Peru: Geol. Soc. Am. Mem. 58, 276 pp.
- Vokes, H. E., 1967. Genera of the Bivalvia: A systematic and bibliographic catalogue: Bull. Am. Paleo., 51 (232): pp. 111-394.

THE DISTRIBUTION OF THE NUDIBRANCH *DORIS VERRUCOSA* LINNE IN THE NORTHWEST ATLANTIC¹

By DAVID R. FRANZ

Systematic & Environmental Biology, Biological Sciences
University of Connecticut, Storrs, Connecticut 06268

The nudibranch *Doris verrucosa* Linné is a warm-water

¹ Contribution No. 61 of the Marine Research Laboratory, University of Connecticut.

amphi-atlantic species which is distributed, in the Eastern Atlantic, from the coast of England and Ireland, the Mediterranean, the Adriatic and the west coast of Africa. Prior to the new distributional records noted below, the species in the West Atlantic was reported from Sao Sebastiao, Brazil (Marcus, 1955), the west coast of Florida (Bergh, 1894), South Carolina (in Eliot, 1910, p. 96) and Sapelo Island, Georgia (Marcus & Marcus, 1967). The purpose of this report is to note the occurrence and confirm the identification of *Doris verrucosa* on the Atlantic coast of North America northward to Buzzards Bay, Massachusetts. The new records reported here are based on collections from Beaufort, North Carolina, the York River (Chesapeake Bay, Virginia), the mouth of the Mystic River, Connecticut, and Sugar Loaf Spring, Buzzards Bay, Massachusetts. The Beaufort specimens were graciously provided by Mrs. Ann McCrary, University of North Carolina, and the York River specimens by Dr. Alex Marsh, Virginia Institute of Marine Sciences, Gloucester Point, Va. The preserved Connecticut slugs were collected by Dr. Robert Cerwonka, Potsdam State College, Potsdam, New York and the single living animal from the Mystic River was collected by Mr. Gordon Hendler of the University of Connecticut. The Buzzards Bay specimens, collected in 1902 by U. N. Edwards, came from the collection of the Academy of Natural Sciences of Philadelphia (ANSP No. 85618) and the author is indebted to Dr. Robert Robertson and Kaniaulono Bailey for the loan of this material. It is a pleasure to acknowledge the generosity of all of these workers.

Since the records reported here represent a significant northward extension of the known range of this species, selected descriptive and anatomical data supporting the identification are provided.

Doris verrucosa Linné, 1758

Altogether, 13 West Atlantic specimens have been examined, 4 each from Beaufort and Virginia, 3 from Connecticut and 2 from Buzzards Bay. The smallest animal (preserved) was 7.5 mm. in length and 5.3 mm. wide. Other specimens ranged upward to a maximum of 45 mm. by 28 mm. for the living slug from the Mystic River (Fig. 2). The length varies from 1.4 to 1.7 times the width among the preserved animals. The preserved slugs are opaque white, with a slight hint of yellow in one specimen. The living animal was a dingy orange color, somewhat paler ventrally and

on the dorsal surface of the foot (which was visible when the animal moved about). The notal papillae are moderately dense but do not touch each other. The larger are rounded, the smaller either rounded or conical. The oral tentacles are smooth and not well developed. The rhinophores are perfoliate and the rhinophoral pits are surrounded by a pair of large papillae, one on each side. In some specimens, a smaller papilla may occur on the posterior and/or the anterior margin of the pit. The branchial pit is surrounded by a mixture of larger and smaller papillae. There are 12 to 15 unipinnate branchiae.

The labial cuticle is smooth and colorless. In the four specimens dissected, the radula formulae were as follows: (25-26) -0- (25-26), (31-35) -0- (31-35), (35-36) -0- (35-36), (27-47) -0- (27-47). The total number of rows ranged from 24 to 42. The teeth are hamate, but variable in size and appearance depending on position within a row (Fig. 1). The extreme inner and outer teeth are smallest and the outer two or three may be rudimentary.

The ampulla of the hermaphroditic gonoduct is thick, with a muscular coat, and enters the anterior gland mass far forward and ventrally. The bifurcation of the hermaphroditic gonoduct into male and female systems occurs within the anterior gland mass. The prostatic portion of the vas deferens leaves the gland mass anteriorly near the point of confluence with the ampulla and continues along the anterior margin of the gland mass for a short distance before diverging from it. The sharp division between prostatic and muscular portions of the vas deferens is marked by a 180 degree reflection and at this point, a penial retractor muscle inserts on the vas deferens. Distally, the vas deferens is visibly coiled within its muscular sheath. The vagina begins in the copulatory atrium and joins the duct of the spermatheca near its origin. Just distal to this, the convoluted uterine duct and the duct of the spermatocyst diverge, the former entering the anterior gland mass. A non-glandular oviduct connecting the gland mass and the atrium of oviposition is not present. The relationship of the various parts of the anterior reproductive complex are shown diagrammatically in Fig. 3.

The living animal from Beebe Cove was collected sublittorally from a drifted frond of *Laminaria* in very shallow water (water temp. 24.5°C at bottom).

Discussion

These specimens differ only slightly from Brazilian animals described by Marcus (1955), and specimens from Sapelo Island, Georgia, reported by Marcus and Marcus (1967). In a recent paper, Schmekel (1968) has drawn a distinction between *D. verrucosa* and the very similar but smaller species *D. ocelligera* Bergh, 1881, based predominantly on size relationships, the size and shape of the mantle papillae, the size and number of rhinophoral and branchial papillae and, internally, the absence of a penial retractor (*ocelligera*). The general body proportions (length less than twice the width), the existence in the present animals of both small and large branchial papillae and a penial retractor, all of which are absent in *D. ocelligera*, eliminate the latter species. *Doris verrucosa* must also be compared with *D. bovena* Marcus, 1955. In this species, however, the rhinophoral pits are guarded by 8-10 papillae whereas the branchial margin is smooth. Furthermore, bifurcation of the hermaphroditic gonoduct occurs outside of the anterior gland mass.

In her recent discussion of *D. verrucosa* from the Gulf of Naples, Schmekel (1968) emphasizes the importance of the height of the larger notal papillae, some of which in the figure provided, are about twice as high as wide. However, these elongate papillae were not present in two of three specimens from the Gulf of Naples examined by the author (ANSP 84454). In comparing the maximum diameter and density of notal papillae of all specimens including the three Naples animals noted above it is evident that these characters are very variable and tend to form a continuous intergradation which does not appear to be correlated either with geography or size of animal.

In all other aspects of internal and external anatomy, the West Atlantic specimens are very similar those from the Gulf of Naples.

Zoogeography: The relatively large size of the Connecticut slugs suggests that these were older animals which had survived at least one winter in Beebe Cove. Winter conditions in the cove are severe, and temperatures may remain below 5°C for extended periods. Frequently an ice sheet covers most of the cove and may persist several weeks, depending on weather conditions. Two of the four York River specimens were collected in December suggesting the possibility that the species is also permanent resident in Ches-

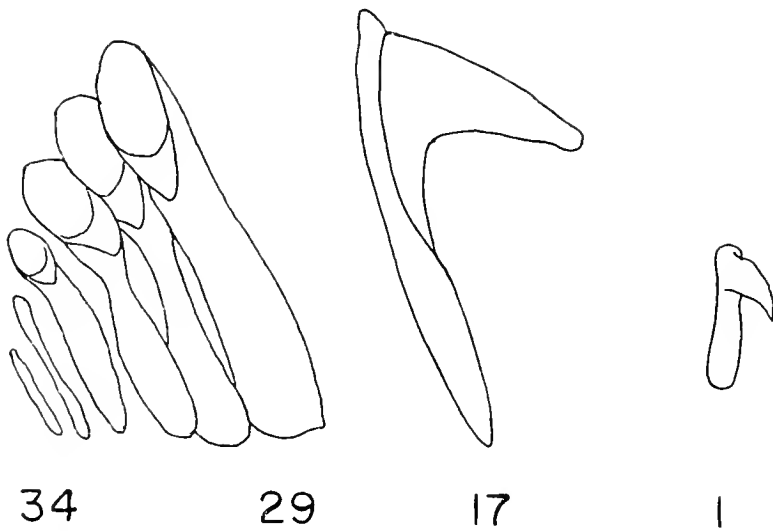


Fig. 1. Radula of *Doris verrucosa*. Teeth are numbered beginning medially and increasing laterally. No's 1 and 17 are lateral views, 29 to 34 frontal views. Line equals 0.1 mm.

peake Bay. In Beebe Cove, intensive collecting by the author and his students during the summers of 1967 and 1968 failed to turn up a single specimen. Since the single animal from the cove collected in July of 1969 was in the process of oviposition, the thermal requirements for reproduction were obviously present at that time. However, it is possible that successful recruitment of *D. verrucosa* in New England is dependent on the seasonal incursion of larvae from the Gulf Stream. The influence of the Gulf Stream is commonly indicated by the presence of *Sargassum* in Block Island and Fishers Island Sounds. In any case, the shallow waters of the Mystic River as well as other local areas in southern New England do attain summer temperatures high enough to provide the thermal requirements for the survival and reproduction of this species.

D. verrucosa is the only warm-water amphiatlantic nudibranch known to extend north of Cape Hatteras, N. C.

REFERENCES CITED

- Bergh, R., 1894. Die Opisthobranchien. Reports on the dredging operations . . . by the U. S. Fish Commission Steamer "Albatross." Bull. Mus. Comp. Zool. Harvard Univ. 25 (10) : 125-233.
 Eliot, C., 1910. The British Nudibranchiate Mollusca, Part VIII (Supple.) Ray Society, London.

Marcus, E., 1955. Opisthobranchia from Brazil. Univ. Sao Paulo, Bol. 207: 89-200.

Marcus, E. and E. Marcus, 1967. Some opisthobranchs of Sapelo Island, Georgia, U.S.A. Malacologia 6 (1-2) : 199-222.

Schmekel, L., 1968. Die Gattung *Doris* (Gastropoda, Nudibranchia) im Golf von Neapel. Publ. Staz. Zool. Napoli 36 (2) : 167-197.



Fig. 2. *Doris verrucosa* Linne collected from the mouth of the Mystic River (Beebe Cove) Connecticut in July, 1969. Maximum length of the living animal was 45 mm.

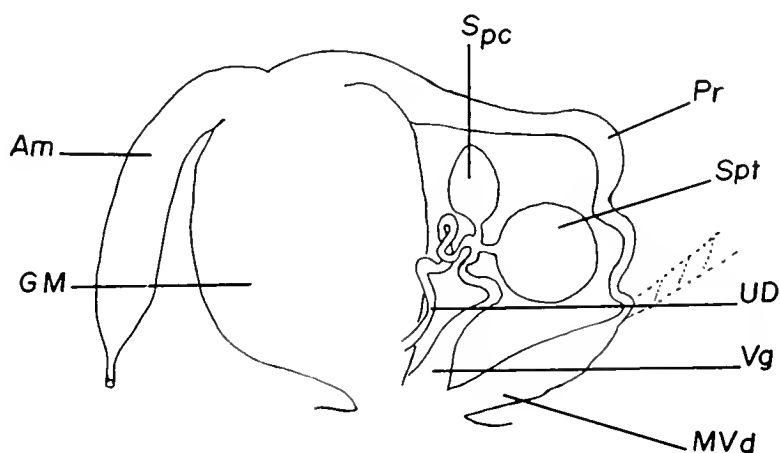
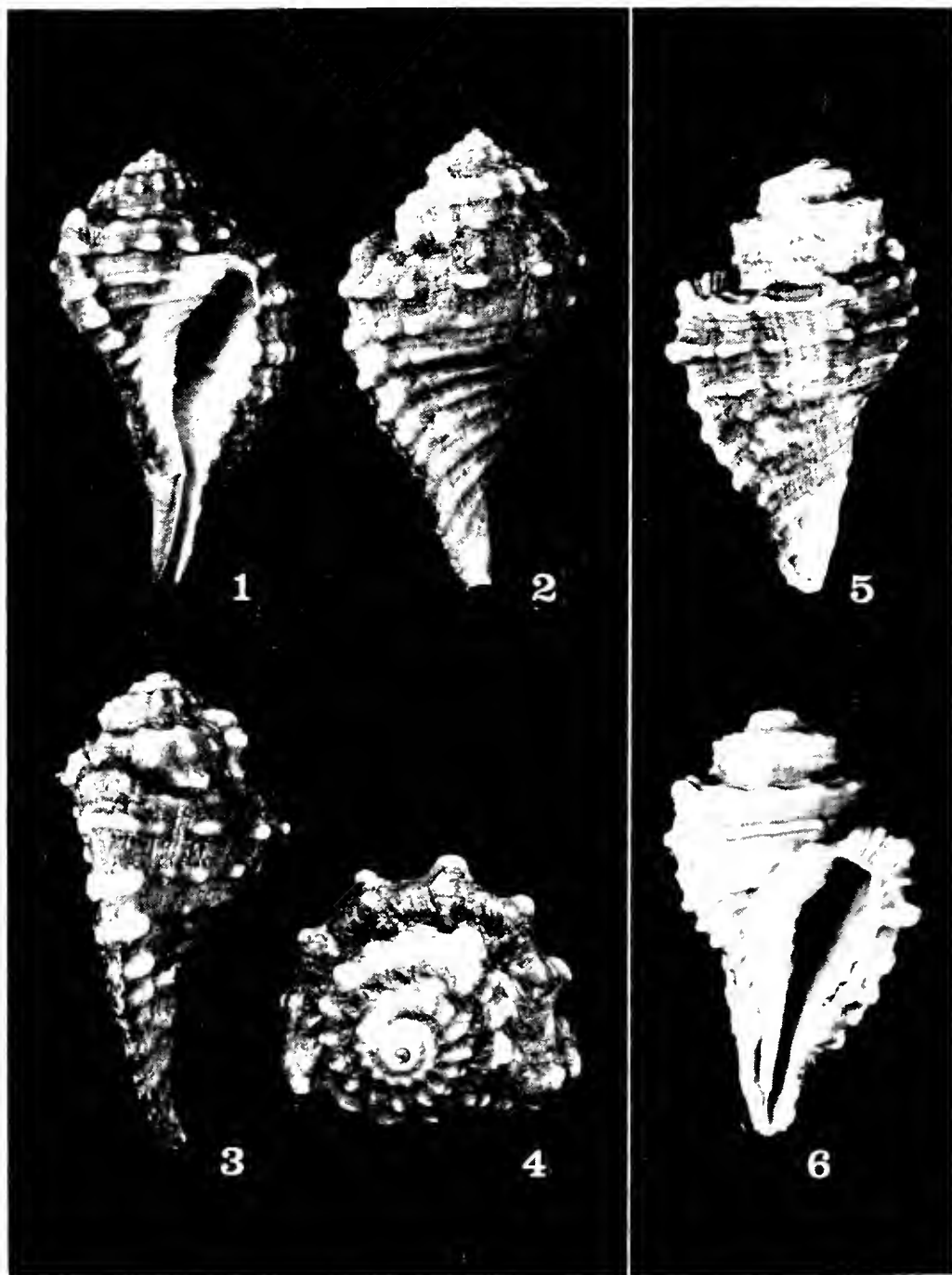


Fig. 3. Anterior genital complex of *Doris verrucosa* (diagrammatic). Am, ampulla; GM, anterior genital mass; MVd, muscular vas deferens; Pr, prostatic vas deferens; Spc, spermatocyst; Spt, spermatheca; UD, uterine duct; Vg, vagina.

CYMATIUM BOSCHI, NEW SPECIES FROM
THE ARABIAN SEA

By R. TUCKER ABBOTT¹ AND HAL LEWIS²



Cymatium (Ranularia) boschi new species. Figs. 1-4 holotype. Figs. 5 and 6, paratype, A.M.N.H. no. 139206.

¹ Delaware Museum of Natural History, Greenville, Del. 19807.

² Wynnwood, Pennsylvania.

Dr. Donald Bosch, a physician at the American Mission Hospital in Muscat, Oman, recently sent us a *Cymatium* for identification. It appears to be undescribed, and in our careful search of the literature we could find only one illustration of it (fig. 0, pl. 10, second edition, 1757, Argenville's *L'Histoire Naturelle . . . Conchyliologie*) which, to our knowledge, has never had a binomial name applied to it. The new species is in the subgenus *Ranularia* Schumacher, 1817 (type by Herrmannsen's 1847, p. 388 designation: *Tritonium clavator* Chemnitz, 1780, which is now *gutturium* (Röding, 1787)).

Cymatium (*Ranularia*) *boschi* new species

Figs. 1-6

Description: Shell reaching about 78 mm. (almost 3 inches) in length, subtrigonal, spirally corded, with tabulate whorls, and colored whitish with a suffusion of soft light-brown. Nuclear whorls (total number unknown), fragile, smooth, horn-brown. Postnuclear whorls 4; rather squarish or tabulate in the spire, the shoulder being either squarely or roundly angulate. Suture minutely impressed. Below it, the top of the whorl is flattish and with 9 or 10 retractively slanting, narrow, small, axial folds or ridges. Body whorl with 11 or 12 spiral cords, the upper one or two bearing 10 or 11 small nodes. The cords below this becoming increasingly small and smooth. Siphonal canal relatively broad and short. Aperture elongate, broad at both ends. Outer lip thick, with 3 to 5 poorly developed broad clumps of twin lirae or teeth. Parietal wall raised, white-glazed, glossy, with weak, short spiral lirae well within the aperture. Outer lip with a large, rounded, nodular varix. Upper or posterior end of aperture broadly V-shaped and not bounded by large teeth. Periostracum light-brown, moderately thick over the entire shell, deciduous when dry, axial fimbriated in short, thin blades. Soft parts and operculum unknown.

Measurements (mm.):

Length	Width	
75	41	Holotype; Delaware Mus. Nat. Hist.
78	45	Figured paratype AMNH 139206
66	38	Paratype. Donald Bosch collection
51	35	Paratype; ANSP 188844

Types: The type locality is Al Masirah Island, Oman Protec-

torate, southeast Arabia. The holotype is in the Delaware Museum of Natural History (Greenville, Delaware) no. 22862. Figured paratype and 3 worn and partially broken paratypes in the American Museum of Natural History, no. 139206. One paratype in the Donald Bosch private collection. One paratype from Muscat, Gulf of Oman, in the Academy of Natural Sciences of Philadelphia, no. 188844. This species is named for Dr. Donald Bosch, a physician who has added greatly to our knowledge of south Arabian marine mollusks.

Comparative Remarks: *Cymatium boschi* differs from other members of the subgenus *Ranularia* in having the upper part of the whorls tabulate. The flat top of the shoulder is about at right angle to the wall of the whorl above. It also has a broad and rather short siphonal canal, a feature which gives the whole shell a somewhat trigonal shape. The upper or posterior end of the white aperture is broadly V-shaped and not constricted into a pseudo-posterior canal as that in such species as *trilineatum* (Reeve, 1844), *moritinctum* (Reeve, 1844) and *sinense* (Reeve, 1844). The parietal wall is white, a feature found in *caudatum* (Gmelin, 1791) which has a deep sutural channel, and in *sinense*, which has 6 or 7 very large teeth on the inside of the outer lip. *C. boschi* differs from *gutturium* (Röding, 1789) in that the latter has a globular body whorl with beaded spiral cords and a peach to reddish oval peristome. The periostracum of *boschi* appears to lack the occasional, long, dark-brown setae seen in *gutturium* and *sarcostoma* (Reeve, 1844).

ASPELLA MYRAKEENAE, NEW SPECIES FROM WESTERN MEXICO

BY WILLIAM K. EMERSON¹ AND ANTHONY D'ATTILIO²

Recent collecting along the central coast of western Mexico has brought to light specimens of a distinctive new species of aspellid gastropod. We take extreme pleasure in describing this interesting discovery in honor of Dr. A. Myra Keen, distinguished paleontologist of Stanford University, California.

¹ American Museum of Natural History, Central Park West, New York, N. Y. 10024.

² San Diego Natural History Museum, California 92001

Aspella (? *Dermomurex*) *myrakeenae* Emerson and D'Attilio, new species Figures 1-11

Description of holotype: Shell is nearly 25 mm. in height, broadly ovate, widest below the median area, with six convex whorls; surface is chalky white; the worn nucleus consists of $1\frac{1}{2}$ whorls. There are 6 broad, strong, obliquely descending axial ridges on the spire and the body whorl which continues over the shoulder. The varices are attached buttress-like to the preceding whorl where they are excavated on the receding side. The excavations continue as moderately deep basins on the shoulder. The suture is deeply impressed. The spiral sculpture is mostly diminished or obsolete in the areas between the varical sculpture. On the varices the spiral sculpture consists of strong, large cords of which there are 2 on the spire and 5 on the body whorl. Where the spiral sculpture on the varices reaches the surface of the body whorl, the deeply carved troughs between the spiral cords terminate abruptly. The polished, ovate aperture is widely flaring, and it has a white border. More deeply within the aperture there are visible 6 spiral bands of brown. The outer lip is crenulated by the spiral cords over-running the axial sculpture; 6 denticles are present within the outer lip; anteriorly the first 2 are paired, followed by 3 evenly spaced, with the 6th and most posteriorly situated one weakly developed. The siphonal canal is moderately short, open, and recurved. The fasciole retains a strong ridge consisting of the blunt ends of the axial varices. A slight umbilical excavation occurs at the upper portion of the attachment of the fasciole to the canal. The white chalky layer of the shell surface is finely, axially striated. Where the outer chalky layer of the shell is abraded off the surface, especially on beach specimens, the harder shelly matter below is revealed to be incised by close, regularly spaced, sharp edged, spiral channels. If the chalky layer is completely removed, the areas between the spiral cords on the varices and the body whorl are found to be colored a rusty brown.

The holotype, which is the largest specimen we have seen, is not complete, being holed in the apertural side of the body whorl (figs. 1,2). Specimens with mature apertures have a white porcelainous layer that covers and completely masks the brown bands in the aperture. The apertural bands are most prominent on speci-

mens with newly formed outer lips (fig. 6). The exterior color bands under the chalky layer are commonly poorly developed or they may be lacking in some specimens (figs. 4, 5). Not all 5 varices are equally well-developed on the body whorl of some specimens; one or more varices may be reduced to raised ridges which remain only at the suture as buttresses that are attached to the previous whorl.

The operculum has a basal nucleus with the inner surface well marked (figure 10).

The radular dentition (figure 11) is similar to that of *Aspella obeliscus* (A. Adams), and in major characters recalls those of the Typhinae and the Muricinae.

Measurements: Holotype, 24.8 mm. in length, 14.5 mm. in width; largest paratype: 20.8 mm. in length, 13 mm. in width; smallest paratype: 9.9 mm. in length, 7.1 mm. in width.

Type locality: Banderas Bay, Nayarit, Mexico; intertidal, under rocks.

Type specimens: holotype, A.M.N.H. No. 153298; 9 paratypes, A.M.N.H. No. 155887; collected by Joseph and Helen DuShane, January 12-18, 1969. Additional paratypic specimens will be deposited in the following collections: San Diego Natural History Museum, Los Angeles County Museum of Natural History, California Academy of Sciences, Department of Geology of Stanford University, Department of Geology of Tulane University, and that of Joseph and Helen DuShane of Whittier, California.

Other specimens examined:

La Paz, Baja California, Mexico, A.M.N.H. No. 155905, 1 specimen, intertidal, under rocks, Twila Bratcher, April, 1965, *ex.* - Ben and Ruth Purdy collection. Mariner's Point, Mazatlan, Sinaloa, Mexico, A.M.N.H. No. 152592, 2 specimens, intertidal, Tom Rice, February 12, 1968. Off Mazatlan, Mexico, A.M.N.H. No. 152600, 2 specimens, by SCUBA diving, December, 1968, *ex.* - Richard Petit collection. Barra de Navidad, Jalisco, Mexico, A.M.N.H. No. 153353, 12 specimens, intertidal, under rocks, low tide, Joseph and Helen DuShane, February 1, 1969.

Remarks: Specimens of this new species are currently masquerading in collections under the name *Aspella indentata* (Carpenter, 1857, p. 527), a poorly known taxon originally described from Mazatlan, Sinaloa, Mexico (Keen, 1968, p. 425, pl. 58, fig. 64,

holotype illustrated). Carpenter's species, which is rare in collections, has an elongate shell with a thick, denticular outer lip formed in the comparatively small aperture of the mature specimens. We have examined a beach-worn specimen with a mature aperture (see fig. 3, herein), which is in the collection of the Los Angeles County Museum of Natural History and it is accompanied by a label reading "Santelmo Bay, West Mexico, Capt. Fred Lewis." According to Dr. James H. McLean (*in litteris*), Capt. Lewis collected in the Bay of Panama as well as along the Mexican coast. Therefore, this specimen may well have been obtained by him at Bahía Santelmo, Isla del Ray of the archipelago of the Perlas Islands, Panama, the type locality of the holotype of *Aspella perplexa* Keen, 1958.

Keen (1958a, pl. 30, fig. 13) illustrated what appears to be a specimen of this new species from Zihuatanejo, Guerrero, Mexico, as a questionable hypotype of *Aspella perplexa* Keen (1958a, p. 248, pl. 30, fig. 11, holotype). Keen (1958b, p. 365, fig. 378) has referred the holotype of her *A. perplexa* to the synonymy of *A. indentata* Carpenter, but she subsequently expressed doubt regarding this action after examining Carpenter's type specimen (Keen, 1968, p. 425). The illustration of the holotype of *A. perplexa*, suggests a well-preserved specimen that appears to have an immature outer lip. Additional Panamanian material is needed before the mature apertural characters of specimens from this region can be determined with certainty. The limited data, however, suggests to us that the holotype of *A. perplexa* probably falls within the expected morphological range of variability of Carpenter's *A. indentata* and that this species apparently ranges from Panama to Mexico.

The new species also has been confused with the Panamic *Aspella obeliscus* (A. Adams, 1853, p. 269; Sowerby, 1879, *Murex* sp. 90b, pl. 402, fig. 233, not *Murex obeliscus* Dillwyn, 1817, which is *Cerithium obeliscus* Bruguière, 1792 [= *Rhinoclavis sinensis* (Gmelin, 1791)]). "*Murex*" *obeliscus* A. Adams was originally described without locality data, but this taxon was subsequently cited from St. Thomas Island in the Caribbean (Sowerby, 1879). This citation led to the supposition on the part of students that *A. obeliscus* was a junior synonym of the Caribbean *A. paupercula* (C. B. Adams, 1850, p. 60; Clench and Turner, 1950, p. 323, pl. 39,

fig. 16, lectotype, Jamaica, type locality). Specimens from western Mexico (figure 7), however, appear to be close to Sowerby's figured specimen. At our request, Dr. John Peake of the British Museum (Natural History) kindly provided us with photographs of three syntypes of *A. obeliscus*, two of which are figured herein (figs. 8,9). None of the syntypes of *A. obeliscus* now possesses the rich coloring as depicted by Sowerby's illustration, although one of the syntypic specimens (fig. 9) closely approaches it in general form and proportions. Sowerby's drawing may represent a composite of the three syntypes, or it may have been based on non-typological material.

As pointed out by Keen (1968, p. 425), the New World representatives of *Aspella* (*sensu lato*) are in dire need of study. Since the last review of this muricid group appeared (Hertlein and Strong, 1951, pp. 77-79), much new information has accumulated. However, critical data on the radular and opercular characters of the type species of the supraspecific taxa that have been placed in this complex must be obtained before generic assignments can be undertaken with confidence.

Acknowledgements: We are grateful to the following friends and colleagues for valuable assistance in providing us with specimens and for extending courtesies of various kinds: Mrs. Twila Bratcher of Hollywood, California, Mr. and Mrs. Joseph DuShane of Whittier, California, Dr. A. Myra Keen of Stanford University, Stanford, California, Dr. James H. McLean of the Los Angeles County

EXPLANATION TO FIGURES (Opposite Page)

Figures 1,2,4,5,6, *Aspella* (?*Dermomurex*) *myrakeenae*, n.sp. Figs. 1,3, holotype. Figs. 4,5, La Paz, Baja California, Mexico; specimen with mature aperture; ex-Purdy collection. Fig. 6, Paratype, showing immature outer lip with color banding. All X2. Fig. 3, *Aspella* (?*Dermomurex*) *indentata* (Carpenter, 1857), a beach-worn specimen from "Santelmo Bay," [Isla del Ray, Panama], L.A.C.M.N.H. No. A5498, courtesy of Dr. J. H. McLean; specimen with mature aperture. X2. Figures 7-9, *Aspella* (?*Dermomurex*) *obeliscus* (A. Adams, 1853). Fig. 7, Masachapa, Nicaragua, beach specimen, courtesy of Dr. E. H. Vokes. X2. Figs. 8-9, 2 of 3 syntypes in British Museum (Natural History), *teste* Peake; photographs courtesy of Dr. John Peake (enlarged).



1



2



3



4



5



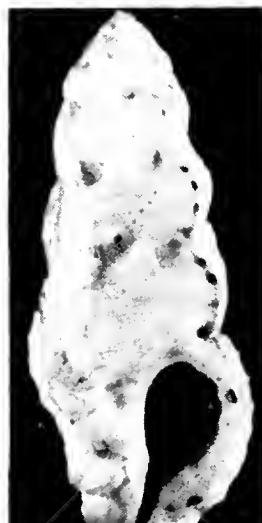
6



7



8



9

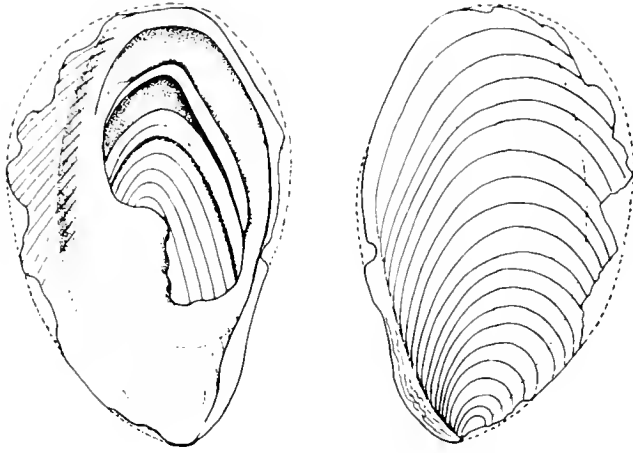


Figure 10. Inner and outer surfaces of the operculum of *Aspella* (?*Dermomurex*) *myrakeenae*, new sp.; greatly enlarged.

Museum of Natural History, Los Angeles, California, Dr. John Peake of the British Museum (Natural History), London, Mr. Richard Petit of Ocean Drive Beach, South Carolina, Mr. and Mrs. Ben Purdy of San Diego, California, Dr. George E. Radwin of the Natural History Museum, San Diego, Mr. Thomas C. Rice of Poulsbo, Washington, Mr. and Mrs. Carl Shy of Westminister, California, and Dr. Emily H. Vokes of Tulane University, New Orleans, Louisiana.

LITERATURE CITED

- Adams, Arthur, 1853. Proc. Zool. Soc. London, for 1851, pp. 267-272 (December, 7).
- Adams, C. B., 1850. Contributions to Conchology, no. 4, pp. 56-68 (January).
- Carpenter, P. P., 1857. Catalogue of the collection of Mazatlan shells in the British Museum collected by Frederick Reigen. London, i-iv + ix-xvi + 552 pp.
- Clench, W. J., and R. D. Turner, 1950. Occas. Papers on Mollusks, Harvard Univ., 1 (15): 233-404, pls. 29-403.
- Hertlein, L. G., and A. M. Strong, 1951. Bull. So. Calif. Acad. Sci., 50 (2): 76-80, pl. 26.
- Keen, A. M., 1958a. Bull. Amer. Paleont., 38 (172): 236-255, pls. 30-31 (May, 23).
- , 1958b. Sea shells of tropical West America; marine mollusks from Lower California to Colombia, i-ix + 624 pp., 1700 text figs. Stanford Univ. Press. (December, 5).
- , 1968. Veliger, 10 (4): 389-439, pls. 55-59, 171 text figs. (April, 1).

Sowerby, G. B., Jr. (Second of Name), [Editor], 1879. *Thesaurus conchyliorum, or Monographs of genera of shells*. London, 4, *Murex* pp. 1-55, pls. 380-403.

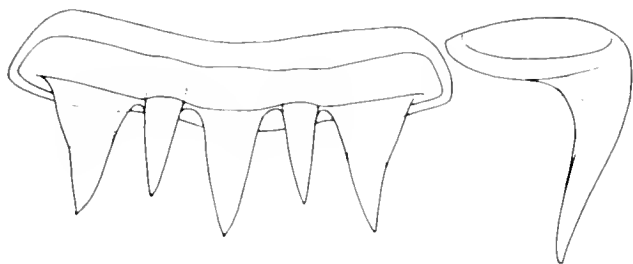


Figure 11. Radular dentition showing central tooth and one lateral tooth of *Aspella* (?*Dermomurex*) *myrakeenae*, n. sp., from Coastcomate, Jalisco, Mexico, C. and L. Shy, leg.; greatly enlarged; (radular mount courtesy of Dr. G. E. Radwin).

NEW MITRIDAE AND VOLUTOMITRIDAE

By WALTER O. CERNOHORSKY

Auckland Institute & Museum, Auckland, New Zealand

Family Mitridae

Genus *Cancilla* Swainson, 1840

Type species by subsequent designation (Herrmannsen, 1846)
Tiara isabella Swainson, 1831.

Cancilla scrobiculata crosnieri new subspecies. Figs. 1 and 2

Description: Shell moderately large, fusiform-elongate, thick and solid, uniformly creamy-white under a thin, black periostracum. Teleconch of 9 convex whorls, protoconch missing, sutures distinct but not deep. Sculptured with irregular and unequal spiral threads, about 42 on the body whorl and 19 on the penultimate whorl in the type; some spiral threads are broader and flatter than others in the same specimen. Interstices of spirals almost smooth in parts, but finely axially striate or even pitted in some portion of the shell; fine, close-set and somewhat obsolete longitudinal growth striae override spirals cords and interstices. Aperture equal in height to the spire, narrow and elongate, smooth within, edge of labial lip thickened and simple; columella with 5 oblique folds. siphonal fasciole calloused, moderately straight or slightly recurved.

All specimens were collected devoid of animal. The new sub-

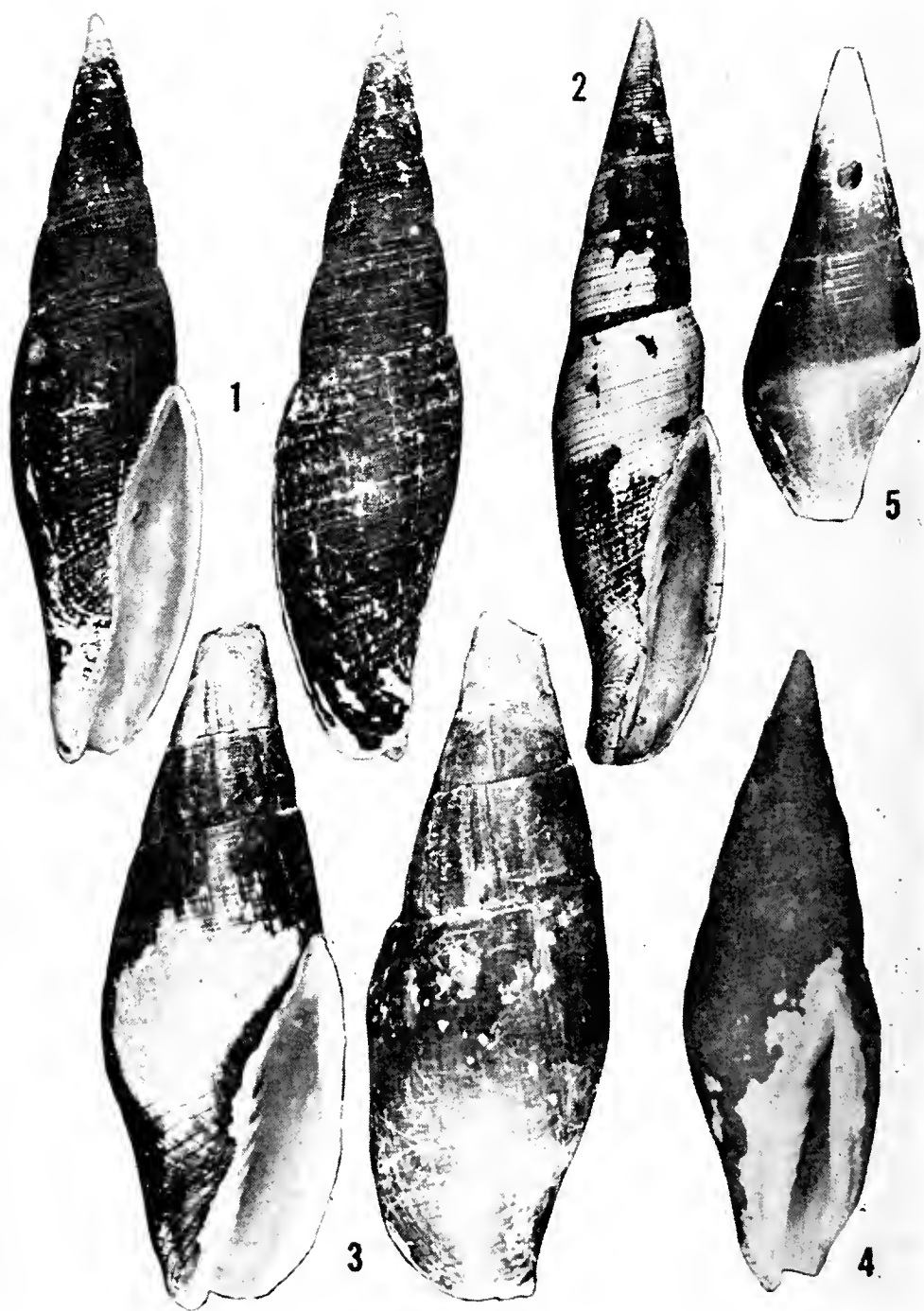


Fig. 1. *Cancilla scrobiculata crosnieri* Cernohorsky. Holotype DMNH No. 22392. Point Noire, Congo, West Africa, 135 metres. Length 73.1 mm. Fig. 2. *C. scrobiculata crosnieri* Cernohorsky. Paratype ANSP No. 316133. Point Noire, Congo, West Africa, 135 metres. Length 89.8 mm. Fig. 3. *Mitra pele* Cernohorsky. Holotype USNM No. 679608. 1 mile NW of Pitcairn Id., Pacific Ocean, 65-70 fathoms. Length 41.1 mm. Fig. 4. *M. pele* Cernohorsky. Paratype BPBM. Off Waikiki, Oahu, Hawaii, 100 feet. Length ca. 49.0 mm. (photo Dr. A. Kay, Honolulu). Fig. 5. *M. pele* Cernohorsky. Paratype USNM No. 679610. 1 mile NW of Pitcairn Id., Pacific Ocean. Length 24.9 mm.

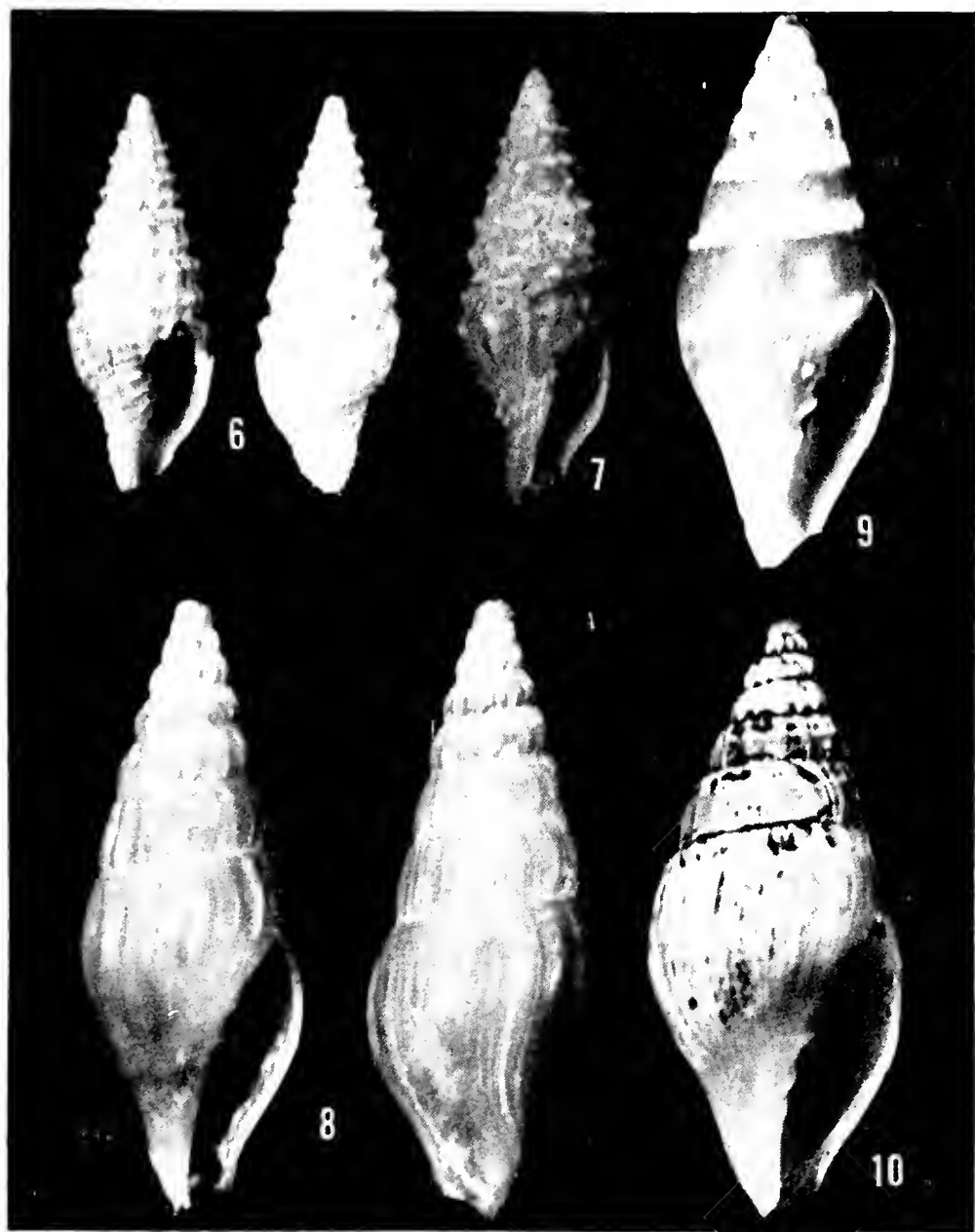


Fig. 6. *Vexillum (Costellaria) nodospiculum* Cernohorsky. Holotype USNM No. 274716. Off Pt. Dumurug, Masbate, Philippines, 153 fathoms. Length 6.0 mm. Fig. 7. *V. (C.) nodospiculum* Cernohorsky. Paratype USNM No. 279019. Off Silungan Id., Borneo, 305 fathoms. Length 6.3 mm. Fig. 8. *Microvoluta joloensis* Cernohorsky. Holotype USNM No. 288396. Off Cagayan Id., Jolo Sea, Philippines, 508 fathoms. Length 9.5 mm. (slender, costate specimen). Fig. 9. *M. joloensis* Cernohorsky. Paratype USNM No. 290150. Higan Bay, Nth. Mindanao, Philippines, 415 fathoms. Length 8.6 mm. (slender, smooth specimen). Fig. 10. *M. joloensis* Cernohorsky. Paratype USNM 290189. Off Apo Id., Sth. Negros, Philippines, 256 fathoms. Length 9.3 mm. (broad, obscurely costate, internally lirate specimen).

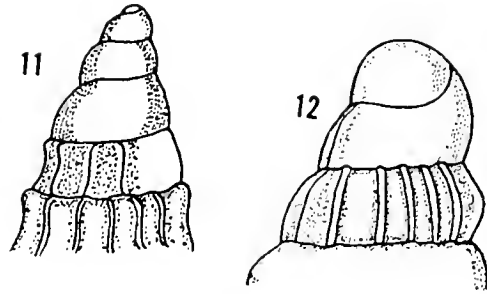


Fig. 11. Early whorls of *Vexillum (Costellaria) nodospiculum* Cernohorsky.
 Fig. 12. Early whorls of *Microvoluta joloensis* Cernohorsky.

species exhibits the usual amount of variation one has come to expect in Mitridae, some specimens being more slender than others, spiral cords are either elevated and rounded or depressed and flat. There are 35-45 spiral threads on the body whorl and 13-20 on the penultimate whorl; interstices may be moderately smooth, finely axially striate or even prominently pitted. The number of adult whorls will vary from 8-10 and columellar folds from 4-5.

Holotype measurements: Length 73.1 mm.; max. diam. 18.5 mm.; height of aperture 37.0 mm.

Type locality: Point Noire, Congo, West Africa, Lat. 4°57'S, Long. 11°22'E, in 135 metres (4-V-1962).

Distribution and types: Holotype No. 22392 in the Delaware Museum of Natural History, Greenville; paratype No. 1 (89.8 x 21.0 x 43.7 mm.) in the Academy of Natural Sciences of Philadelphia ANSP 316133; from the type locality; paratype No. 2 (85.3 x 23.2 x 43.7 mm.) in the Laboratoire de Malacologie, Muséum d'Histoire Naturelle, Paris, from Point Noire, Congo, 160 metres (leg. J. Marteau, 12-VIII-1966); paratype No. 3 (76.8 x 21.0 x 38.6 mm.) in author's collection, Auckland Institute & Museum, Auckland, from coast of Dahomey, Lat. 6°05'N, Long. 2°37'E, in 150-200 metres (leg. A. Crosnier, 24-X-1963); paratype No. 4 (71.4 x 18.8 x 36.6 mm.) and paratype No. 5 (56.4 x 14.6 x 28.8 mm. - juvenile specimen) in the Delaware Museum of Natural History, Greenville, from coast of Dahomey, 150-200 metres.

The West African subspecies is the living representative of the European Mio-Pliocene *Cancilla scrobiculata* (Brocchi, 1814), and has close relatives in Miocene deposits of the Caribbean and Northern South America: *C. symmetrica* (Gabb, 1873) from Dominica, *C. limonensis* (Olsson, 1922) from Costa Rica and *C. sieversi*

(Rutsch, 1934) from Venezuela. The remaining two surviving members of the *scrobiculata* complex, are geographically widely separated: *Cancilla larranagai* (Carcelles, 1947), a somewhat stunted, less prominently sculptured form from temperate waters off Uruguay (58-65 fathoms), and the tropical *C. isabella* (Swainson, 1831) from the Sino-Japanese region.

The new subspecies is named for Prof. A. Crosnier, Point Noire, Congo, who first brought the species to our attention, and for his work on West African molluscs.

Genus *Mitra* Röding, 1798

Type species by subsequent designation (Montfort, 1810) *Voluta episcopalis* Linnaeus, 1758 = *Voluta mitra* Linnaeus, 1758.

Mitra pele new species.

Figs. 3 and 4

Description: Shell medium in size, ovate-lusiform, thick and solid, tan in colour under a thin dark brown periostracum. Teleconch of $4\frac{1}{2}$ almost flat-sided whorls, portion of spire and protoconch missing, sutures distinct but not deep. Sculptured with smooth and thin spiral grooves, about 30 on the body whorl and 9 on the penultimate whorl; under magnification, close-set, fine longitudinal striae are discernible on the shell. Aperture about equal in height to the spire, moderately narrow, white in colour and smooth within; labial lip thickened and simple, columella with a white prominent callus and 7 oblique, close-set folds, siphonal canal straight.

In the paratype specimens, the spiral grooves on the body whorl number from 25-30 and columellar folds from 5-7. Juvenile specimens are light orange-brown on the lower half of the body whorl while remaining whorls are dark brown.

Holotype measurements: Length 41.1 mm. +; max. diam. 14.5 mm.; height of aperture 22.7 mm.

Type locality: Station PIT VI, Haul 20, 1 mile NW of Pitcairn Island, Pacific Ocean, in 65-70 fathoms, stones and coral rubble (Pele Expedition, 20-x-1967).

Distribution and types: Holotype No. USNM 679608 in the U.S. National Museum, Washington; paratype No. 1, USNM 679609 (39.4 x 14.5 x 21.8 mm.), from the type locality, in the U.S. National Museum, Washington; paratype No. 2, USNM 679610 (24.9

x 9.2 x 13.2 mm. - juvenile specimen), Sta. PIT, Haul 19, 1 mile NW of Pitcairn Island, in 55-65 fathoms, in U.S. National Museum; paratype No. 3 (ca. 49.0 mm.) off Waikiki, Oahu, Hawaii, in 100 feet, in Bernice P. Bishop Museum, Honolulu.

Mitra pele is the same species as *M. nigra* J. Cate, 1960 (non *Voluta nigra* Gmelin, 1791), from 75 fathoms, Keahi Lagoon, Oahu Hawa'i. *Mitra nigra* (Gmelin), based on an illustration in Chemnitz (1788, p. 168, pl. 151, figs. 1430, 1431) from "Guinea," West Africa, is the same species as *Mitra fusca* Reeve, 1844, and of authors, but not of Swainson, 1824. *Mitra castanea* Röding, 1798, and *M. melaniana* Lamarck, 1811, are objective synonyms, *M. adansonii* Philippi, 1849, a subjective synonym of *M. nigra* (Gmelin); the species is restricted to the North-eastern Atlantic and West Africa. Chemnitz (loc. cit.) remarked that he received the "genus" (not species) from Tranquebar and Greenland; from India he most probably received *Mitra chinensis* Griffith & Pidgeon, 1834, and from Greenland very likely *Volutomitra groenlandica* (Beck in Möller, 1842).

The taxon *Mitra nigra* (Gmelin), has also been erroneously associated with the Austral-New Zealand species *Vicimitra contermina* Iredale, 1936 (non *Mitra contermina* Bellardi, 1887). The Austral-Neozelanic species is *Mitra carbonaria* Swainson, 1822, and the distributional range of the species is south from New South Wales to Tasmania, across the Tasman to New Zealand (synonym *M. maoria* Finlay, 1927) and northward to the Kermadec Islands. *Mitra carbonaria* is thinner and less solid than the Polynesian *M. pele*, has finer, punctate spirals and a brown aperture; the anterior of the parietal wall is slightly concave, dark brown in colour, and lacks the white columellar callosity of *M. pele*. The spiral striae become basal cords on the siphonal fasciole in *M. carbonaria*, whereas in *M. pele* the spiral grooves continue to the base, with intervening flat spiral cords. Juvenile specimens of the two species differ quite prominently.

Mitra fusca Swainson, 1824, described from the Indian Ocean, was subsequently well illustrated by Swainson (1831), but wrongly figured by Reeve (1844) and erroneously attributed to the Atlantic Ocean by subsequent authors. *Scabricola* (*Swainsonia*) *fusca* (Swainson), is the earliest name for the Indo-Pacific species subsequently described as *Mitra limata* Reeve, 1845, *Cylindra formosa* Pease,

1868, and *Mitra zephyrina* Sowerby, 1874.

Mitra pele has not been recorded outside the Hawaiian-Polynesian region.

Genus *Vexillum* Röding, 1798

Subgenus *Costellaria* Swainson, 1840

Type species by monotypy *Mitra rigida* Swainson, 1821 = *M. semifasciata* Lamarck, 1811.

Vexillum (Costellaria) nodospiculum new species Figs. 6, 7, 11

Description: Shell very small, fusiform, moderately thin, white in colour throughout. Teleconch of $5\frac{1}{2}$ concave and nodulose whorls, part of protoconch missing but remaining whorls smooth and milky-white; whorls concavely excavated centrally, sutures rather deep. Sculptured with prominent axial ribs, about 17 on the body whorl and 13 on the penultimate whorl; axial ribs form coarse nodes anteriorly and posteriorly to the sutures. Interstices of axial ribs smooth, except on the centre of the body whorl where 4 prominent spiral cords are visible. Siphonal fasciole with 6 distinct and oblique cords, 4 of which are extensions of the columellar folds. Aperture narrow, shorter than spire, lirate within, labial lip constricted anteriorly; columella with 4 oblique folds, anterior fold the smallest, parietal wall with a callus pad.

The range of variation in 49 specimens of the type series is as follows: length 3.2-6.6 mm.; width 34%-41% of length; height of aperture 36-45% of length; teleconch $4\frac{1}{2}$ - $5\frac{1}{2}$ whorls; protoconch $2\frac{1}{2}$ - $3\frac{1}{2}$ whorls; axial ribs on body whorl 8-17; on penultimate whorl 9-14; spiral striae on body whorl 0-12; on penultimate whorl 1-4; columellar folds 3-4. In some specimens the spiral striae are obsolete on the body whorl, while in others spiral sculpture is prominent.

Holotype measurements: Length 6.0 mm.; max. diam. 2.2 mm.; height of aperture 2.7 mm.

Type locality: Station 5394, off Pt. Dumurug, Masbate, Philippine Islands, in 153 fathoms, green mud (U.S. Bureau of Fisheries).

Distribution and types: Holotype USNM 274716a in U.S. National Museum, Washington; paratypes No. 1-12, USNM 274716, from the type locality, in the U.S. National Museum; paratype

No. 13 from the type locality in the author's collection, Auckland Institute & Museum; paratypes No. 14-15, USNM 259640, Sta. 5194, off Chocolate Id., Nth. Cebu, Philippines, 148 fathoms, green mud, 56.5°F; paratype No. 16, USNM 259766, Sta. 5197, off Cabilao Id., W. Bohol, Philippines, 174 fathoms, green mud, 54.3°F; paratype No. 17, USNM 259755, same data as preceding; paratype No. 18, USNM 277531, Sta. 5212, off Sibugay Id., E. of Masbate, Philippines, 108 fathoms, grey mud and sand, 59.9°F; paratype No. 19, USNM 288875, Sta. 5407, off Ponson Id., Camotes Islds., Philippines, 350 fathoms, green mud; paratype No. 20, USNM 287908, Sta. 5408, off Capitancillo Id., N. Cebu, Philippines, 159 fathoms, green mud, 55.4°F; paratypes No. 21-24, USNM 289179, Sta. 5409, same as preceding, but in 189 fathoms; paratypes No. 25-32, USNM 289146, Sta. 5419, off Lauis Pt., E. Cebu, Philippines, 175 fathoms, green mud, 54.5°F; paratype No. 33, USNM 290285, Sta. 5513, Iligan Bay, Nth. Mindanao, Philippines, 505 fathoms, grey mud and fine sand, 52.8°F; paratype No. 34, USNM 286714, Sta. 5541, off Tagolo Pt., Nth. Mindanao, Philippines, 219 fathoms, fine sand and broken shale, 53.3°F; paratypes No. 35-36, USNM 278819, Sta. 5589, Sibuko Bay, off Mabul Id., Borneo, Indonesia, 260 fathoms, fine grey sand and mud, 45.7°F; paratypes No. 37-46, USNM 279049, Sta. 5592, off Silungan Id., Borneo, Indonesia, 305 fathoms, green mud, 43.3°F; paratype No. 47, Sta. 5592, same data as preceding, in author's collection, Auckland Institute & Museum; paratype No. 48, USNM 235018, Cebu, Philippines, coll. Bartsch. (all types in the U.S. National Museum, collected by the U.S. Bureau of Fisheries, except as listed).

This minute, spinose deep-water species is one of the smallest Vexilline species recorded. It bears no real resemblance to any of the Recent species, but is a distant relative of the common, intertidal species *Vexillum* (*Costellaria*) *coronatum* (Helbling, 1779), *V. concentricum* (Reeve, 1844) [= *Mitra mucronata* Broderip, 1836 = *M. echinata* A. Adams, 1853], and *V. stephanucha* (Melvill, 1897). These three species greatly exceed *V. nodospiculum* in size (20-45 mm.), are brightly coloured and of different form and sculptural arrangement.

Family Volutomitridae

Genus *Microvoluta* Angas, 1877

Type species by monotypy *Microvoluta australis* Angas, 1877.

Microvoluta joloensis new species

Figs. 8-10

Description: Shell small, fusiformly-elongate, livid in colour. Teleconch of $6\frac{1}{2}$ convex whorls, protoconch of 2 smooth, globose nuclear whorls. Sculptured with angulate and arcuate axial ribs, about 13 on the body whorl and 18 on the penultimate whorl, and obsolete spiral striae; sutures well impressed and with a faint indication of a sutural girdle. Aperture narrow, equal in height to spire, smooth within (in holotype), labial lip thin and simple, constricted towards the base; columella concave, with 4 thin, distant folds, posterior fold shorter than succeeding one. Siphonal canal spout-shaped, notch lacking, siphonal fasciole slightly twisted towards the aperture.

The species is very variable in shape, colour and sculpture. Some specimens are fusiformly-elongate, others more ovate; some individuals are off-white, banded with livid, or are livid in colour and have a white sutural band. Many specimens have a well-formed sutural girdle, and axial ribs tend to become obsolete on the last 2 whorls; axials number up to 18 on both whorls, and spirals are either distinct or obscure. From the 51 specimens examined, 38 specimens were smooth within the aperture, while 13 specimens were lirate; this feature is typical of Volutomitridae. The length of the type specimens ranged from 3.6 - 10.4 mm., the width from 34%-43% of length and the height of aperture from 42%-52% of length.

Holotype measurements: Length 9.5 mm.; max. diam. 3.4 mm.; height of aperture 4.6 mm.

Type locality: Station 5123, off Cagayan Island, Jolo Sea, Philippine Islands, in 508 fathoms, grey mud and compact sand, 49.8°F (U.S. Bureau of Fisheries).

Distribution and types: Holotype No. USNM 288396 is in the U.S. National Museum, Washington; paratypes No. 1-11, USNM 288396 and paratype No. 12, USNM 288475, are from the type locality; paratype No. 13, USNM 288686, Sta. 5424, off Cagayan Id., Jolo Sea, 340 fathoms, 50.4°F; paratypes No. 14-28, USNM 288133, Sta. 5425, off Cagayan Id., Jolo Sea, 495 fathoms, 49.4°F;

paratypes No. 29-38, USNM 290425, and paratype No. 39, USNM 290450, Sta. 5512, Iligan Bay, Nth. Mindanao, 445 fathoms, grey mud and fine sand, 52.8°F; paratypes No. 40-41, USNM 290260 and paratype No. 42, USNM 290260a, Sta. 5513, Iligan Bay, Nth. Mindanao, 505 fathoms; paratypes No. 43-49, USNM 290134, Sta. 5529, off Balicasag Id., Sth. Bohol, 441 fathoms, grey mud, 53°F; paratype No. 50, USNM 290189, Sta. 5538, off Apo Id., Sth. Negros, 256 fathoms, green mud and sand, 53.3°F (all Philippine Islands, U.S. Bureau of Fisheries). All paratypes are in the U.S. National Museum, with the exception of paratypes No. 11 and No. 38, which are in the author's collection, Auckland Institute & Museum, Auckland.

This is the first *Microvoluta* reported from the Philippine Islands. The species is superficially similar to *Microvoluta intermedia* (Dall, 1890), from the West Indies, but in that species the whorls are angulate, axial ribs thin, straight and obscure below the presutural ramp. With other *Microvoluta* species it shares features of thin shell, bulbous protoconch, spout-shaped siphonal canal, absence of siphonal notch, smooth or lirate labrum and a recurved beak.

Acknowledgements: I would like to thank Dr. R. T. Abbott, Delaware Museum of Natural History, Greenville, and Dr. Harald A. Rehder, Smithsonian Institution, U.S. National Museum, Washington, for giving me the opportunity to describe these new molluscan species.

LITERATURE CITED

- Cate, J. M., 1960. Range extension and synonymy for *Mitra nigra* (Schröter, 1788). *The Veliger*, 3 (2): 49-51.
- Chemnitz, J. H., 1788. Neues systematisches Conchylien-Cabinet. Nürnberg, 10: 1-376; pls. 137-173.
- Reeve, L. A., 1844-45. *Conchologia Iconica*. Monograph of the genus *Mitra*. London, Vol. 2, pls. 1-39.
- Swainson, W., 1824. The characters of several new shells, belonging to the Linnaean Volutae, with a few observations on the present state of Conchology. *Quart. Journ. Sci. Lit. & Arts*, 17 (33): 28-38.
- , 1829-33. *Zoological Illustrations*. London, 2nd series, Vols. 1-3, pls. 1-136.
-

REDISCOVERY OF THE LIMPET, *ACROLOXUS*
COLORADENSIS (BASOMMATOPHORA:
ACROLOXIDAE), IN COLORADO¹

By GEORGE W. BRYCE, JR.

Department of Biology, University of Colorado, Boulder, Colorado

Professor Junius Henderson of the University of Colorado on two different occasions in the 1920's collected specimens of *Acroloxus coloradensis* (Henderson), a small limpet, from a mountain lake in Boulder County, Colorado. Since that time the species has been reported alive only once (Russell and Brunson, 1967) from the United States, although many others (Basch, 1963) have searched specifically for it on various occasions at its type locality.

In October 1966 at Peterson Lake I found two living specimens of *A. coloradensis*. A subsequent careful search by me and Scott J. Herrmann, of the Department of Biology at Southern Colorado College, revealed a small population in shallow littoral regions of the lake.

Henderson first found this elusive species on 28 June 1920, and sent specimens to Bryant Walker for identification. In the Catalogue of Mollusca of the University of Colorado Museum, entry number 10,113 in Henderson's own hand quotes Walker as writing, "Most remarkable. Notice the spine-like apex. 'For the love of Mike' get more."

Despite Walker's enthusiastic imploration for more specimens, the species was not again collected until August 1924 by Junius and F. G. Henderson. Soon thereafter, Walker (1925) described the species, naming it *Ancylus hendersoni* after its discoverer. Five years later Henderson (1930) found that Walker's specific designation was preoccupied, having been previously used in the same genus by Walker in 1908. Henderson renamed the limpet *Ancylus coloradensis*. Subsequently the species has been assigned to the genus *Acroloxus* (Taylor, 1960), since it is closely related to the European *Acroloxus lacustris* (Linnaeus). Cytological studies of *A. lacustris* (Burch, 1962) suggest that it merits separate familial status, if not indeed separate ordinal status.

Peterson Lake, the type locality misidentified by Henderson as "Eldora Lake," is located in Boulder County, Colorado, about 5.5

¹ Contribution No. 53, Limnology Laboratory, University of Colorado.

kilometers WSW of Nederland and about 25 kilometers WSW of Boulder (35 road-kilometers from Boulder). Its exact location is T. 1 S., R. 73 W., at adjacent corners of sections 20, 21, 28, and 29 (39°56'N, 105°34'W). A smaller lake lying about 0.1 kilometer to the southeast and about 30 feet higher in elevation is the true "Lake Eldora." Commercial developments at Peterson Lake have markedly changed the character of its swamps in the past several years.

Peterson Lake is situated in the Montane Zone of the Southern Rocky Mountains at an elevation of 2818 m (9245 feet) and in the coniferous forest characteristic of that zone. It is about 0.15 X 0.65 km in size. Total residues of its water ranged from 32.4 to 63.1 mg per l from October 1966 to August 1967, and bound carbonates, as determined by methyl orange titrations, ranged from 12.83 to 19.30 ppm over the same period. Its waters are derived from swampy areas and are brown-stained, probably by humic extractives. Pennak (1945) found a water color of 30 on the platinum-cobalt scale and a pH of 7.7. Water temperatures at the time of limpet collections ranged from 11.1 to 1.8° C in October 1966 and up to 18.8° C in August 1967. A complete ice cover (up to 36 cm thick in 1966-67) is present for about four months each year.

The present population of limpets is concentrated at the west or head end of the lake and especially along the southwest shore. Population densities at favorable sites were found to range up to 72 individuals per square meter. Dorsal shell color of individual limpets varies from light tan flecked with dark brown to almost solid dark-brown with occasional spots of light brown. A random sample of 42 specimens ranged in width and length from 0.64 X 1.04 mm to 2.97 X 4.88 mm, with a mean of 1.66 X 2.69 mm. The small, flattened shells of the animals blend almost exactly with the dark rocks on which they live, and their observation is exceedingly difficult, especially in the shade.

The southwest side of the lake which harbors the main population center is thickly strewn with the small to large granitic rocks on which the limpets live. On this shore the coniferous forest crowds up to the edge of the lake, producing almost day-long shade in many areas and resulting in cooler average temperatures, as evidenced by the much longer period of ice cover on this shore than on the rest of the lake.

The limpets have since been collected during different seasons almost invariably on the undersurfaces of the rocks, apparently affording a shady, algal-free niche for the limpets. Thus, it is indicated that they may feed on the film of bacteria and detritus. The limpets have been collected from a water depth of a few centimeters to about 40 cm. Dr. Robert W. Pennak (personal communication) suggests that their population center may lie here where the moderate wave action would keep the rocks free of the dense brown silt which is deposited over most of the lake bottom.

The small planorbid snail *Promenetus coloradoensis* (Baker) is almost invariably associated with the limpets. Taylor (Hibbard and Taylor, 1960) synonymizes this species with the more common *P. exacuon* (Say). Both the limpest and the snail are frequently found on the same rock, but the planorbid ranges more widely over the surfaces of individual rocks than does the limpet.

Since the collections of Henderson, living *Acroloxus coloradensis* has been reported once from the United States, and the only other reports known to me are from Canada. In the summer of 1925 Alan Mozley (1926) reported the species from Jasper National Park, Alberta. In a later report (1930) Mozley clarified the localities in which *A. coloradensis* were collected as Lake No. 1 (not Iris Lake as reported in his 1926 paper) and Lake No. 5, both in an area of about 53° N latitude in Jasper Park. Iris Lake, only about 0.4 km east of Mozley's Lake No. 1, lies at an altitude of 1306 m (4285 feet) in the Canadian Rocky Mountains. Mozley sent specimens to Walker who identified them as the species under discussion.

In the United States, Russell and Brunson (1967) have reported this species from Lost Lake, Glacier National Park, Montana. This lake lies at about 49° N latitude at an elevation of 1433 m (4700 feet). These authors also found the limpet "on the undersurfaces of rocks in shallow water near the shore."

It is significant that *Acroloxus coloradensis* has also been recently reported by Dwight W. Taylor (1954, 1960) as a fossil from the High Plains. It has been found in the Berends fauna, a Pleistocene assemblage of southwestern Kansas and adjacent Oklahoma (Taylor, 1954) and also in the Dixon local fauna of southern Kansas and the Sand Draw local fauna of northcentral Neb-

raska (Taylor, 1960), both the latter of early Pleistocene age. Evidently *A. coloradensis* is a relict species once widely distributed over North America, but now with a distinctly disjunct distribution. Its present altitudinal and latitudinal distribution indicates that it is a cold-water stenothermal species. It is likely that living populations of *A. coloradensis* will be found to occur in other infrequent and scattered Rocky Mountain lakes in which the continued existence of the species has been fortuitously favored.

I wish to express appreciation to Dr. Robert W. Pennak (Department of Biology, University of Colorado) and Dr. Hugo G. Rodeck (Director, University of Colorado Museum) for their aid and cooperation in this investigation.

LITERATURE CITED

- Basch, P. F. 1963. A review of the recent freshwater limpet snails of North America (Mollusca: Pulmonata). *Bull. Mus. Comp. Zool.*, 129: 399-461.
- Burch, J. B. 1962. Cytotaxonomic studies of freshwater limpets (Gastropoda: Basommatophora). I. The European lake limpet, *Acroloxus lacustris*. *Malacologia*, 1: 55-72.
- Henderson, J. 1930. *Ancylus coloradensis*, new name for *A. hendersoni* Walker, 1925, not 1908. *Nautilus*, 44: 31.
- Hibbard, C. W., & D. W. Taylor. 1960: Two late Pleistocene faunas from southwestern Kansas. *Contrib. Mus. Paleontol.*, Univ. Michigan, 16: 1-223.
- Mozley, A. 1926. Preliminary list of the Mollusca of Jasper Park, Alberta. *Nautilus*, 40: 53-56.
- Mozley, A. 1930. Reports of the Jasper Park Lakes investigations, 1925-26. The Mollusca of Jasper Park. *Trans. Roy. Soc. Edinburgh*, 56: 647-669.
- Pennak, R. W. 1945. Some aspects of the regional limnology of northern Colorado. *Univ. Colorado Studies*, Ser. D, 2: 263-293.
- Russell, R. H., & R. B. Brunson. 1967. *Acroloxus coloradensis* from Montana. *Nautilus*, 81: 33.
- Taylor, D. W. 1954. A new Pleistocene fauna and new species of fossil snails from the High Plains. *Michigan Univ. Mus. Zool. Occ. Papers*, No. 557, 16 p.
- Taylor, D. W. 1960. Late Cenozoic molluscan faunas from the High Plains. *Geol. Surv. Prof. Paper* 337, 94 p.
- Walker, B. 1925. New species of North American Ancyliidae and Lancidae. *Michigan Univ. Mus. Zool. Occ. Papers*, No. 165, 13 p.

LONGEVITY IN ASHMUNELLA, MONADENIA AND SONORELLA

BY MUNROE L. WALTON

1108 North Central Ave., Glendale, California 91202

An earlier contribution (Walton, 1963) recorded data concerning the length of life in west American land snails kept in my basement cellar. Information concerning the cages, feeding and methods of observation is presented there and is not repeated. Additional records have been accumulated and death claimed several individuals reported as still alive in 1963. The opportunity is taken to provide data on several species and to summarize longevity data on three genera. For assistance in organizing this data and interpreting the results, I am indebted to Alan Solem, Curator of Lower Invertebrates, Field Museum of Natural History, Chicago. The species order follows Walton (1963).

Ashmunella kochi amblya Pilsbry: Collected $1\frac{1}{2}$ miles up Pine Springs Canon, Guadalupe Mts., Culberson Co., Texas on March 19, 1952. Two adults were found dead in January 1957 and August 1958. They had produced two young that were first observed in June 1954. In October 1956, at 21 mm. in diameter, the young formed a reflected lip. The second generation shells were observed in copulation on June 25, 1959 and a single juvenile was discovered on August 6, 1959. Although the second generation shells were observed in copulation again on August 7, 1960, no additional young were produced prior to their deaths in August and November 1962. The single third generation specimen reached 18 mm. in diameter, but did not have a reflected lip, at its death about July 30, 1962, although reaching within a week of three years. In contrast, the second generation specimens reached maximum shell growth in $2\frac{1}{4}$ years, mated at age 5 and 6, and survived to $8\frac{1}{4}$ and $8\frac{1}{2}$ years.

Ashmunella townsendi Bartsch: Collected on Hwy. 380, 5.5 miles west of Lincoln, Lincoln Co., New Mexico on October 19, 1951. Ten adults were caged and subsequently found dead on March 10, 1960 (4 specimens); June 8, 1960; September 4, 1960; September 21, 1960; March 16, 1963; April 4, 1963; May 24, 1963; January 20, 1964 February 25, 1964; and September 18, 1965. Survival time ranged from $8\frac{1}{2}$ to just under 14 years for individuals that had

already completed shell growth. If we assume that $2\frac{1}{4}$ to $2\frac{1}{2}$ years is required for completion of shell growth as in *A. kochi amblya*, then a life span of $16\frac{1}{2}$ years is quite possible.

Sonorella sabinoensis dispar Pilsbry: Collected from east side of Pima Canyon, Santa Catalina Mts., Pima Co., Arizona on November 4, 1965. Three caged juveniles reached adulthood and reproduced before being found dead on May 25, 1967; November 8, 1967; and December 4, 1967. Twelve second generation young were hatched February 26, 1966. Four died when very small; two were found dead May 8, 1966 at 4 mm. in diameter; one on November 7, 1966 at 9 mm. in diameter; one on January 16, 1967 at 15 mm. in diameter; one on March 12, 1967 at 17 mm. in diameter; while three developed a reflected lip by December 15, 1967 and are still alive in April 1969. Fourteen third generation young appeared July 15, 1968 and remain under observation. An additional eleven young were noticed first as an egg mass on September 28, 1968 and hatched October 3, 1968. Less than two years were required from hatching to adult size and young were produced in less than $2\frac{1}{2}$ years. This contrasts greatly with *S. virilis* (see Walton, 1963, p. 128), where two juveniles failed to reach adult size in seven years of captivity.

Monadenia fidelis beryllica Chace: Collected four miles north of Gold Beach along U. S. Hwy. 101, Curry Co., Oregon on September 13, 1954. Data on size and death dates for 19 of 22 examples born in July 1956 were given by Walton (1963, p. 130). The last three shells died about August 12, 1963 at 25 mm. in diameter, July 6, 1964 at 29 mm. in diameter and July 22, 1964 at 29 mm. in diameter. Adult size was reached in $2\frac{1}{4}$ to almost 3 years, while maximum survivorship was 8 years for two of the twenty-two specimens.

Monadenia fidelis klamathica Berry: Collected 5 miles upstream from forks of Salmon River, Siskiyou Co., California on August 27, 1959. Nine of ten caged adults died between February 8th and September 30, 1960 (see Walton, 1963, p. 130). The tenth specimen died February 14, 1963, having produced ten young about August 1, 1961. Three examples, at 11, 13 and 15 mm. in diameter, died in October 1962; the remaining seven died in 1963 on about March 4th (23 mm.), July 8th (21 mm. and 15 mm.), July 25th (20 mm.), August 15th (19 mm.), August 28th (21 mm.), and

October 13th (21 mm.) . Adult size is about 30 mm., so that these juveniles reached two-thirds of adult size in 19-26 months.

Monadenia churchi Hanna and Smith: Collected 1.3 miles west of Junction City, Trinity Co., California on December 28, 1959. One 8 mm. juvenile died October 20, 1960 at a size of 11 mm. in diameter. A 13 mm. juvenile became adult at 26 mm. diameter in 1963 and is still alive. Over the years it had been kept caged with an *Ashmunella*. No other snails had been kept in the same cage. Hence the appearance of a young *Monadenia churchi* on June 6, 1968, nearly eight years after the death of the other juvenile *M. churchi*, was most unexpected. Probably this is the result of self-fertilization, since eight year storage of sperm would be exceedingly unlikely, even if an 11 mm. specimen could produce sperm, which is very unlikely. No other *Monadenia* had been kept in the same cage and cross-family fertilization with the *Ashmunella* can be dismissed as a meaningful possibility. The only logical remaining possibility is self-fertilization, since no shifting of specimens between cages was undertaken.

Monadenia troglodytes Hanna and Smith: Collected in a ravine near Samwell Cave, Shasta Co., California on September 20, 1963. A 27 mm. adult remains alive in April 1969. A 13 mm. juvenile reached 19 mm. in diameter on September 19, 1964 and 22 mm. on July 9, 1965 when it was accidentally dropped, broke and died.

Conclusions: Data presented above and in Walton (1963) indicate that species of *Ashmunella* may have a life span of up to $8\frac{1}{4}$ to $16\frac{1}{2}$ years. *Sonorella sabinoensis dispar* reproduced within $2\frac{1}{2}$ years of birth, while *S. virilis* collected as juveniles about two thirds adult size did not develop adult shell characters in over 7 years. Since the range of moisture conditions inhabited by different species of *Sonorella* is so large, considerable variation in length of life is not unexpected. *Monadenia fidelis* has a life span of at least 8 years; *M. churchi* lives for more than 10 years; and *M. troglodytes* lived for over $5\frac{1}{2}$ years as an adult. The latter two species are still under observation and these are not maximum figures. These genera are easily maintained and show considerable variation in growth rates and length of life. While too long lived for use in thesis problems, amateur collectors could accumulate very important data on their life histories and reproductive patterns with minimum equipment and effort.

REFERENCE

- Walton, M. L. 1963. Length of life in west American land snails. *Nautilus* 76 (4) : 127-131.
-

NOTES

NORTHWARD RANGE EXTENSION OF *CYCLINELLA TENUIS* RECLUZ.¹
— The venerid bivalve, *C. tenuis*, was described by Récluz (1852. Jour. de Conch., 3: 250) from Baie de la Pointe-à-Pitre, Guadeloupe in the Lesser Antilles. The northernmost occurrence of *C. tenuis* was reported as Cape Hatteras, North Carolina, by Dall (1889. U.S. Nat. Mus. Bull. 37, p. 56) and Johnson (1934. Proc. Boston Soc. Nat. Hist., 40: 48). Hackney (1944. *Nautilus*, 58: 58) found 3 single valves at Beaufort, North Carolina, during the summer of 1943. Others, including Dall (1902. Proc. U.S. Nat. Mus., 26: 373) and Palmer (1927. *Paleo. Amer.*, 1 (5) : 201) stated that the species lives from as far north as the Cedar Keys, Florida, in the Gulf of Mexico through the West Indies to Sao Paulo, Brazil. Recently, Abbott (1968. *Seashells of North America*, Golden Press, N.Y., p. 234) gave the range as southern Florida and the Caribbean.

Cyclinella tenuis was found by M. L. Wass in the York River at Gloucester Point, Virginia, on August 30, 1961, when a single specimen was taken at a depth of 26 feet. In June 1962, a second specimen was dredged in Chesapeake Bay off the mouth of the Rappahannock River at a depth of 52 feet. Bottom salinity ranges as low as 18 o/oo at the York River site. Both specimens, each about 1 inch long, fragile and seemingly distorted, were originally mistakenly referred to *Dosinia discus*. Subsequently, adult specimens have been taken by Paul Chanley and Michael Castagna near the VIMS Eastern Shore Laboratory at Wachapreague, Virginia. The general scarcity of the species in Chesapeake Bay may be indicated by the fact that the first two specimens were found in a series of samples containing over 50 square meters of substrate. Turgeon figured a specimen from Willis Wharf, Virginia, in her unpublished M.Sc. thesis (1968. Guide to estuarine and inshore bivalves of Virginia. 126 pp., College of William and Mary). Further, specimens in the U.S. National Museum were collected by N. W. Moncure at Buckroe Beach, Virginia, in December 1957,

¹ Contribution No. 329 from VIMS, Gloucester Point, Virginia.

so *C. tenuis* has been in the area for several years. The occurrence of this species in Virginia extends its known range northward by about 180 miles. Apparently, it lives in sandy substrates in shallow water to 36 fathoms.

Specimens examined: (abbreviations: MCZ, Museum of Comparative Zoology; USNM, United States National Museum; VIMS, Virginia Institute of Marine Science). VIRGINIA: off mouth of Rappahannock River; York River, off VIMS pier in 8 m.; off Yorktown; Wachapreague; off Willis Wharf, Eastern Shore (all VIMS); Buckroe Beach (USNM). SOUTH CAROLINA: Magnolia, Charleston Co. (USNM). FLORIDA: off Palm Beach, in 12-14 fms.; Sombrero Key; Pirates Cove, Sugarloaf Key; Sand Id. (all MCZ); west channel entrance to Key West; Dry Tortugas (both USNM); Fort Myers Beach; Sanibel Id. (both MCZ); Mullet Key; Dunedin; Cedar Key (all USNM). TEXAS: Matagorda Bay (USNM); Port Aransas; Port Isabel (both MCZ). MEXICO: Tuxpan, Veracruz (MCZ). CUBA: *Barrera* Station 203, Cabanas Harbor, in 3-12 fms.; Guantanamo, Cuba (both USNM). JAMAICA: Green Id., Hanover; Kingston (both USNM). HISPANIOLA: Puerto Plata, Santo Domingo (MCZ). PUERTO RICO: Mayagüez; Playa de Ponce (both USNM; MCZ). VIRGIN IDS.: St. Thomas (USNM). LESSER ANTILLES: 2 m. S. of Fort George, Scarborough, Tobago, in 36 fms. (MCZ). COLOMBIA: Cartagena (USNM). VENEZUELA: La Orchila (USNM). BRAZIL: Bahia de Todos os Santos, Bahia; Victoria, Espirito Santo, (both MCZ); Rio de Janeiro (USNM); Praia da Urca, Distrito Federal (MCZ); Tabatinga, Sao Paulo (USNM). — K. J. Boss, Museum of Comparative Zoology, and M. L. Wass, Virginia Institute of Marine Science, Gloucester Point, Virginia 23062.

HERMAPHRODITISM IN MARGARITIFERA FALCATA (Gould) (Pelecypoda: Margaritiferidae). — Twenty-six specimens of this species were collected on 4 October 1966 from the Blackfoot River at Idaho Hwy. -34, 13 miles north of Soda Springs, Caribou County, Idaho. The animals displayed the anatomical features of the Margaritiferidae Haas (see Ortmann, 1912, Ann. Carnegie Mus., 8: 223), and the morphology of the demibranchs showed *M. falcata* to be a member of the subfamily Margaritiferinae Modell (1942, Arch. Moll., 74: 184). Histological examination of

the visceral mass of each animal (10 slides per specimen) revealed that *M. falcata* consists only of hermaphrodites; true males and females were lacking in the collection. These monoecious animals contained proportionately much more ovarian tissue than testicular tissue which was irregularly scattered in patches ventro-medially to the digestive gland. Very little gametogenesis was present and few sperm morulae were found, and the great bulk of the gonads was filled with mature gametes. Van der Schalie (1966, *Malacologia*, 5: 77) stated that *M. margaritifera* and *Cumberlandia monodonta* have "occasional hermaphrodites" and that no margaritiferid is "usually monoecious." *Margaritifera falcata* of western North America proves to be an unexpected exception. Among other unionaceans, only the unionids *Lasmigona compressa*, *L. subviridis* (Anodontinae) and *Carunculina parva* (Lampsilinae) are uniformly monoecious (van der Schalie, *Op. cit.*).

None of the 26 individuals of *M. falcata* in this October collection from Idaho were gravid. Murphy (1942, *Calif. Fish Game*, 28: 89-102) demonstrated that in California this species is a short-term breeder (i.e., tachytictic), being gravid only between mid-May and late June. Ortmann (*Op. cit.*) previously reported that the Holarctic *M. margaritifera* is gravid in the summer (p. 232), and that *M. hembeli* of the southern United States is not gravid in February (p. 236). It is peculiar that in *M. falcata* large quantities of mature gametes are present more than seven months before ova can be expected to be released to the demibranchs. — WILLIAM H. HEARD, Florida State University, Tallahassee, Florida, 32306.

ANODONTOIDES FERUSSACIANUS (Lea) in the Susequehanna River watershed in New York State. — In the summer of 1969 a biological survey at the source of the Susquehanna River (Otsego Lake, Otsego County, New York) was undertaken. This study was part of an integrated research program initiated at the Stephen C. Clark Biological Field Station at Cooperstown, a facility of the Biology Department at the State University College at Oneonta.

Six species of Unionidae have been collected in the Lake. They are, in order of abundance, *Lampsilis radiata* (Gmelin), *Anodonta cataracta* (Say), *Elliptio complanata* (Solander), *Alasmidonta undulata* (Say) and *Anodontoides ferussacianus* (Lea). Two living specimens of the latter have been found. The valves are in good

condition and the definitive beak sculpture characteristic of the species shows clearly.

Except for *A. ferussacianus* all species collected are commonly found in the Susquehanna watershed. In the most recent authoritative work on New York State mollusks Clarke and Berg (1959) gave the distribution of *A. ferussacianus* as follows "Mississippi and Ohio drainages, and St. Lawrence drainage from Lake Michigan to the Ottawa River. Lake Champlain, (H. D. Athearn, personal communication)." Those authors felt the records of *A. ferussacianus* in the Susquehanna watershed given by Marshall (1895) were probably incorrect.

In light of this new record Marshall's data should be re-evaluated. On the other hand, the specimens were found only at the mouth of one stream flowing into Otsego Lake. This inlet finds its source in a swampy area to the north which also drains to the Mohawk River.

Because the Erie Canal allows for mixing of the St. Lawrence and Mohawk River faunas it is possible that *A. ferussacianus* has recently been introduced into the Susquehanna watershed via these streams. — WILLARD N. HARMAN, New York State University College, Oneonta.

REFERENCES

- Clarke, A. H. and C. O. Berg., 1959. The freshwater mussels of central New York. Cornell Univ. Agr. Exp. Sta. Mem. 367: 1-79.
- Marshall, W. B., 1895. Geographical distribution of New York Unionidae. N. Y. S. Mus. 48th Ann. Rept. 47-99.

NEWS

The 36th annual meeting of the American Malacological Union will be held from July 16 through July 20, 1970. Winter address for the secretary is: Mrs. Margaret C. Teskey, P.O. Box 239, Big Pine Key, Florida 33043. The meetings will be in Key West, Florida.

The Third Annual meeting of the *Western Society of Malacologists* is scheduled for June 24 to 27, 1970, at Stanford University. Officers of the society are: President: Myra Keen. Vice-President: Eugene V. Coan. Second Vice-President: Beatrice Burch. Secretary: Carol Skoglund. Treasurer: Barry Roth. Councillors-at-large: Twila Bratcher and Robert Talmadge.

A symposium on advances and new techniques in molluscan taxonomy is being organized by Eugene Coan, and other topics for symposia are under consideration. Inquiries about the meeting and applications for membership should be sent to the secretary, Mrs. Paul Skoglund, 3846 East Highland Avenue, Phoenix, Arizona 85018.

PERCY A. MORRIS, well-known writer of popular books on conchology, and Chief Preparator at the Yale Peabody Museum of Natural History, died on December 14, 1969, after a short illness, at New Haven, Connecticut, at the age of 70. He was born January 2, 1899, in Seymour, Connecticut. During his 41 years at Yale he curated the important A. E. Verrill U.S. Fish Commission collections. Among the ten books he authored in natural history, his best known were the "Field Guides to the Shells," published by Houghton Mifflin Co. in 1947 and 1952. He founded the Connecticut Shell Club in 1946 and was its President for 23 years. Mr. Morris is survived by his wife, nee Violet French, and by a daughter, Mrs. Marion Rasey.

PUBLICATIONS RECEIVED

- Okutani, Takashi and John A. McGowan. 1969. Systematics, Distribution and Abundance of the Epiplanktonic Squid (Cephalopoda, Decapoda) Larvae of the Californian Current April, 1954 - March, 1957. Bull. 14 Scripps Inst. Oceanography, Univ. Calif. Press, 90 pp., illus.
- Adam, W. and J. Knudsen. 1969. Quelques Genres de Mollusques Prosobranches Marins Inconnu ou peu Connus de l'Afrique Occidentale. Bull. Inst. royal Sci. nat. Belgique, 44, no. 27: 1-69. New species of *Circulus*, *Cynisca*, *Tornus*, *Macromphalina*, *Cochliolepis*, and *Megalomphalus*, all beautifully illustrated.
- Malacological Review, vol. 1. 1968. 187 pp. Editor unknown; publisher unknown. Address: P.O. Box 801, Whitmore Lake, Michigan 48189. \$5.00. Contains 7 excellent original articles on land, freshwater, marine mollusks and cephalopods. Reproduces "List of Contents" for 13 other molluscan journals published in 1967.
- Haas, Fritz. 1969. Superfamilia Unionacea. Das Tierreich, Berlin, Lief. 88, pp. i-x, 1-663. Walter de Gruyter and Co., 13 Genthiner Strasse, Berlin 30, West Germany. (DM 380, which is about \$103.00!). An exhaustive compendium of the freshwater mussels of the world, giving keys to families, genera and subgenera; synonymies, distributions and remarks for all species, and containing an accounting for about 6,000 names. No illustrations of species.
- Young, Richard E. and Clyde F. E. Roper. 1969. A Monograph of the Cephalopoda of the North Atlantic: the Family Cycloteuthidae. Smithsonian Contributions to Zoology, no. 5, pp. 1-24. Includes *Discoteuthis* new genus, and *D. discus* and *laciniosa* new species.
- Parodiz, Juan J. 1969. The Teritary Non-Marine Mollusca of South America. Annals of Carnegie Museum, vol. 40, 242 pp., numerous photographs, maps, covering 22 families and 48 genera, including 10 new species of freshwater and land gastropods, and *Paleoanculosa*, new genus, in the family Pleuroceridae.
-

Something New in Conchology

**A professional recording of the pronunciations of 1,200
scientific species and generic names of
"SEASHELLS OF NORTH AMERICA"**

also how to enunciate—authors' names, family names, and
dozens of technical names, such as
apophysis, conchiolin, eolis, and
veliger.

Produced and published by R. TUCKER ABBOTT
Sponsored by the Delaware Museum of Natural History
Greenville, Delaware 19807

This is a high-fidelity, long-playing (33 $\frac{1}{3}$ RPM) recording of the names and terms found in Dr. Abbott's new and popular book, *Seashells of North America* (Golden Press, N.Y.). Born in Boston, bred in Canada and a graduate of Harvard College, Dr. Abbott has blended the customary pronunciations of the top professional malacologists in the United States and Canada that set a high standard of acceptability. All names and terms are printed on the record jacket. A unique and long-lasting aid to your study of shells and biology, for only \$4.95 (postage paid).

Obtainable from your favorite shell dealer

WILLIAM H. WEEKS SHELL COLLECTION: New price lists of this famous collection, with full scientific data, are in preparation. Many new additions of fine and rare species are also included. To obtain free copies write:

GEORGE E. JACOBS, 853 Riverside Drive, New York 32, N. Y.

WORLD WIDE SPECIMEN SHELLS for sale. New 1970 Price List on request. "Illustrated Catalog of Popular Marginella Species" now available also, 117 species shown with full data and values listed with cover in color. Price \$2.00.

PHILLIP W. CLOVER
Apartado de Correos 22
Rota Cadiz, Spain

THE NAUTILUS

THE PILSBRY QUARTERLY
DEVOTED TO THE INTERESTS OF CONCHOLOGISTS

EDITORS AND PUBLISHERS

R. TUCKER ABBOTT, duPont Chair of Malacology
Delaware Museum of Natural History, Greenville, Del. 19807

HORACE BURRINGTON BAKER, 11 Cheltenham Road, Havertown, Pa.
(Emeritus Professor of Zoology, University of Pennsylvania)

CHARLES B. WURTZ, *Biology Department*
La Salle College, Philadelphia, Pa. 19141

CONTENTS

Fritz Haas, 1886-1969. By Alan Solem	117
Shell variability in <i>Polygyra dorfeuilliana</i> . By Branley A. Branson	120
<i>Latirus varai</i> , a new fascioliid gastropod from the Caribbean. By Robert C. Bullock	133
Maintenance of land mollusks in the laboratory. By W. Patrick Carney	136
Histological studies of the nephridium and pericardial lining of <i>Quadrula nodulata</i> . By P. R. Myers and D. S. Franzen	139
Another record of insect dispersal of an Ancyliid snail. By Joseph Rosewater	144
Notes	145
News	146

\$4.25 per year (\$4.75 to Foreign Countries) \$1.25 a copy.

Mrs. Horace B. Baker, Business Manager
11 Cheltenham Road, Havertown, Pennsylvania 19083

Second-Class Postage paid at Spring House, Pa.

NAUTILUS:

A quarterly journal devoted to the study of mollusks, edited and published by R. Tucker Abbott, Horace B. Baker (editor emeritus) and Charles B. Wurtz. Business and subscription manager: Mrs. Horace B. Baker, 11 Cheltenham Road, Havertown, Pennsylvania, U.S.A. 19083.

AUTHORS PLEASE NOTE

Matter for publication should be sent to the editor-in-chief, Dr. R. Tucker Abbott, Delaware Museum of Natural History, Greenville, Delaware 19807. Please give your reprint order, if any, when submitting your manuscript. Kindly attempt to conform with the format of the journal, including the style of the references cited and the use of figure numbers of the illustrations. Please correct and return galley proof within 24 hours. The editors reserve the right to ignore unnecessary changes. Authors are charged for engraving blocks of photographs or drawings at cost. Minimum charge for each block is \$3.00. The publishers reserve the right, seldom exercised, to charge \$40 per page of text for state or federally financed research in order to cover costs.

REPRINTS are furnished at printer's rates. ORDERS SHOULD BE WRITTEN ON OR ATTACHED TO FIRST PAGE OF MANUSCRIPT. REPRINTS are shipped, with invoices, by PONY PRINTING, 4 Cloverdale Avenue, Upper Darby, Pennsylvania 19082. PURCHASE ORDERS, when required, and shipping instructions, *MUST* accompany original orders. Extra clerical or bookkeeping work because of delayed receipt of purchase orders will be charged for accordingly.

TEXT PAPER	2 pp.	4 pp.	8 pp.	12 pp.	16 pp.
First, 100 copies	3.40	6.35	13.25	18.70	23.95
Additional 100 .....	.65	1.40	4.30	5.50	6.70
PLATE PAPER					
First 100 copies	3.70	6.90	14.45	20.45	26.25
Additional 100 .....	.90	1.95	5.45	7.25	9.00

Prices subject to change without notice. Postage extra.

THE NAUTILUS is an official organ of the American Malacological Union. Information regarding membership in the Union may be obtained from Mrs. Margaret C. Teskey, Secretary, Route 2, Box 318, Marinette, Wisconsin 54143

BACK ISSUES: Vols. 3-70, if available, can be obtained from KRAUS PERIODICALS, INC., 16 East 46th Street, New York, N. Y. 10017. Vols. 71 to date are available from the NAUTILUS, 11 Cheltenham Road, Havertown, Pennsylvania 19083, and vary in price.

THE NAUTILUS

Vol. 83

April, 1970

No. 4

FRITZ HAAS, 1886-1969

By ALAN SOLEM

Field Museum of Natural History

Chicago, Illinois 60605

The death of Fritz Haas on December 26, 1969, ended a malacological career of sixty-one years that spanned two continents. From 1911 until mid-1936 he was at the Natur-Museum Senckenberg, Frankfurt-am-Main, Germany, first as Assistant Keeper, then as Keeper of Invertebrate Zoology. Forced to leave by Nazi persecution, it was fortunate that on August 1, 1938 he could start a second career as Curator of Lower Invertebrates at Field Museum of Natural History, Chicago. Although he became Curator Emeritus on January 1, 1959, he spent every working day at the Museum until a stroke in December 1965 slowed him considerably. Even after moving to Florida in October 1968, a continual stream of letters and notes kept him in contact with Museum affairs.

Fritz Haas was born January 4, 1886 in Frankfurt-am-Main and received his biological training and outlook through the herpetologist and malacologist Oscar Böttger. His life long interest in and love of the unionid clams came from the influence of Wilhelm Kobelt, who he succeeded as Keeper at the Natur-Museum Senckenberg. During his years at Frankfurt he enjoyed use of matchless library facilities and unrivaled collections. Even an unexpected four year exile in Spain during World War I was turned to scientific use. Almost 2,000 published pages on the mollusks of Catalonia resulted from cooperative work with Arturo Bofill during this exile. In the 1920's he began his classic section "Bivalvia" for Bronn's *Klassen und Ordnungen des Tierreichs*. Eventually this was completed in 1956 after reaching 2,400 published pages. Numerous descriptive and faunistic papers on unionids, plus descriptive reports on expedition materials were written during his Frankfurt years together with "Bau und Bildung des Perlen" (1931) and "Fauna Malacológica Terrestre y de Agua Dulce de Cataluna" (1929).

On arriving in Chicago he had to establish a research library and reference collections where none had existed. Until 1956 he had only casual student help or a summer assistant, with all routine work being done personally. By 1954 the collection contained 54,000 catalogued sets. With the addition of myself as Assistant Curator in 1956 and a full-time assistant in 1959, growth became much more rapid. Even in his retirement years, Fritz Haas spent half-time in routine identifications and cataloguing. The current 165,000 catalogued sets of mollusks and fine library in Field Museum of Natural History stand as a monument to his years of labor. His first years in Chicago saw comparatively little finished research, but growing collections from South America led to numerous descriptive studies. Short field trips to various North American localities also resulted in faunistic publications. As a climax to his career, the editors of "Das Tierreich" asked him to prepare a species level monograph of the freshwater mus-sels. Manuscript for this was completed a few weeks before his stroke, and the 663 page monograph was issued in January 1969. Later the same year saw publication in the *Treatise on Invertebrate Paleontology* of his generic revision of the unionids. This had been submitted for publication in 1950, which surely is close to a record delay.

October 20, 1967 marked the beginning of his sixtieth year as a publishing scientist. This was celebrated by issuing a review of his career, together with a list of his publications and new taxa (Fieldiana: Zoology, 53, pp. 69-144), plus presentation of congratulatory letters from 125 malacologists and colleagues. His productivity totaled more than 300 articles and 385 new molluscan taxa.

Outlines of a career tell little of a man. Fritz was a kindly and gentle person, with a keen wit and quiet humor. He was raised in a different tradition from that common in American scientific circles. The sharp exchanges and testings of ideas and theories that are part of our scientific meetings and discussions were alien to his pattern. Work was a personal search for truth. The test of time and subsequent work would judge the success of this effort. His manuscripts were not shown to others prior to publication and rarely would he comment on new publications. During twenty-five years of association, he would make only gender or diacritical



mark corrections on my manuscripts. After seeing an abysmally poor paper on unionids, he once made the worst criticism I ever heard from him —“He gives some data that will be useful someday.”

This seeming aloofness from his colleagues and profession often led to misunderstandings and problems. After having unrivaled collections at Frankfurt, it was hard for him to adjust to the total lack of such at Chicago. His work pattern seldom involved consulting collections at other museums and some of his papers on Nearctic material were unfortunate. Unionid and South Amer-

ican studies were on much firmer ground and will stand the test of time far better.

In later years his work became more introspective and represented advances from his previous studies rather than from the general state of knowledge in a field. Thus, his "Das Tierreich" monograph was a development from his "A Tentative Classification of the Palearctic Unionids" (1940) and not a completely modern synthesis. It presents the ideas developed in fifty years of work on a group and remains an invaluable landmark.

Much more than in Europe, museum malacology in America has been bound with amateur shell collectors. Fritz never understood the collector's outlook and brief contacts were frequent mutual disasters. Yet a generation of volunteer workers at Field Museum passed from initial fright to delight, affection and respect for him after their initial shocks.

Fritz Haas was a scholar and a gentleman, whose legacy is in knowledge, research facilities and enriched lives.

SHELL VARIABILITY IN *POLYGYRA DORFEUILLIANA*

BY BRANLEY A. BRANSON

Eastern Kentucky University
Richmond, Kentucky 40475

Polygyra dorfeuilliana Lea, probably a trans-Mississippian derivative of *P. troostiana* Lea (Tennessee River Drainage), ranges through Missouri, southeastern Kansas, the eastern two-thirds of Texas and Oklahoma, into the northwestern portion of Louisiana. Pilsbry and Ferriss (1906) compared shells from widespread localities in the snail's range, and Pilsbry (1940) expanded their comments and somewhat re-evaluated concepts of the species. Pilsbry and Ferriss (loc. cit.) indicated that the subspecies *P. dorfeuilliana sampsoni* Wetherby was restricted to the Ozarkian portion of Kansas, Missouri, and Oklahoma, stating that there was, however, "no line to be drawn between them (referring to *sampsoni* and typical *dorfeuilliana*), as in many places both forms and the intergrades occur together" (parentheses mine). They restricted *P. d. percostata* Pilsbry to the Red River area of southwestern Arkansas, whereas *P. d. perstriata* Pilsbry and Ferriss was "another incipient

race . . . from Tushkahoma and Poteau, Oklahoma." *Polygyra dorfeuilliana dorfeuilliana* Lea supposedly occupied the remainder of the general range.

According to Pilsbry (1940), the holotype of *P. dorfeuilliana*

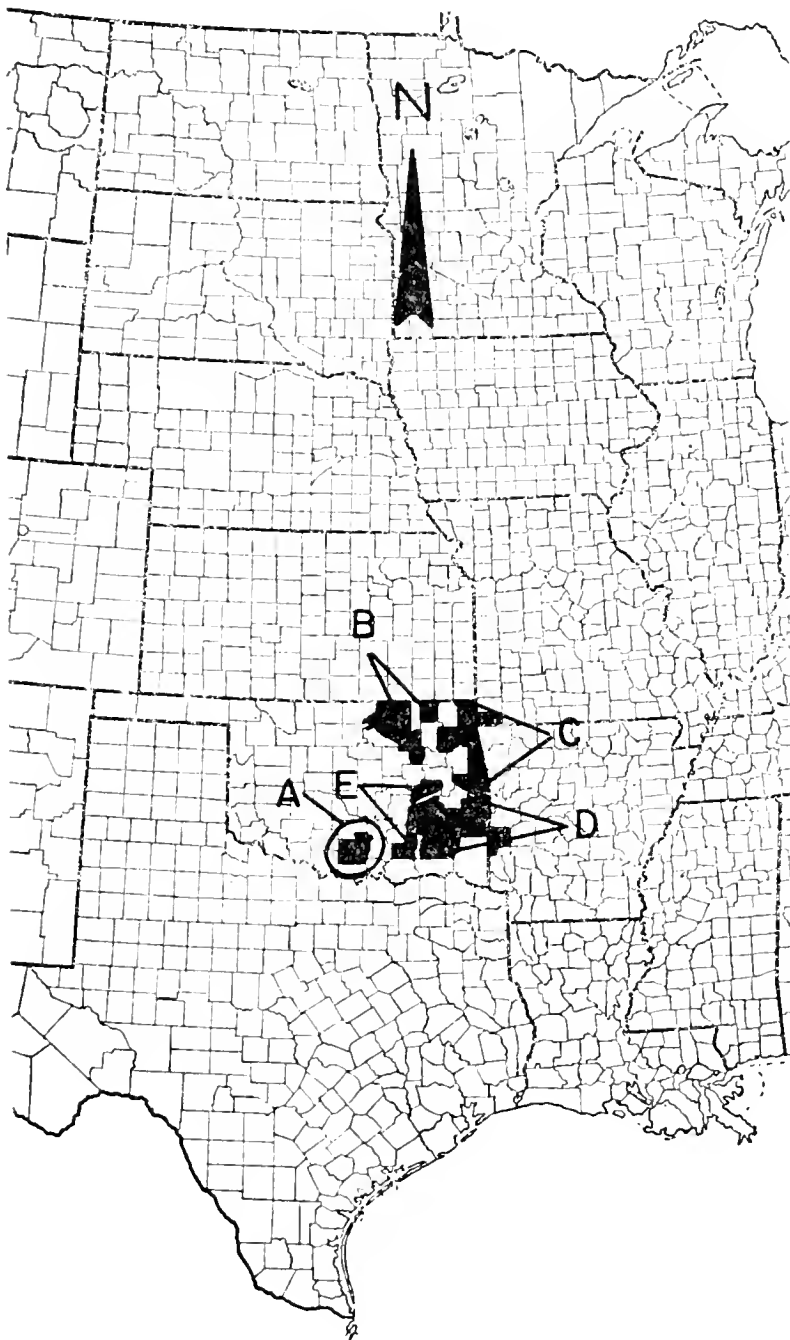


Figure 1. Population sampling areas in Arkansas, Missouri and Oklahoma in *Polygyra dorfeuilliana*. See text for explanation.

has nearly a smooth lower surface, the growth striæ being very fine and crossed by microscopic, impressed spiral lines. Throughout the range, however, both striate and smooth shells were found within single lots. In the typical race, the umbilicus varied by imperceptible stages from moderately narrow to the wide-open one in the nominate form *sampsoni*. Pilsbry (1940) allowed *Polygyra dorfeuilliana sampsoni* to stand as a subspecies, although the form admittedly did not have a definite range exclusive of *P. d. dorfeuilliana*. In *sampsoni*, the shell is supposedly more depressed than in *dorfeuilliana*, and the umbilicus is broader in the last whorl; striation on the base is weak to almost obsolete. According to Pilsbry (1940), shells from northeastern Oklahoma possess heavier striations than ones from Eureka Springs, Arkansas (type locality).

The two remaining "races" were deleted by Pilsbry (1940) as recognizable subspecies. In *P. d. perstriata*, the umbilicus was supposed to be widely open, as in *sampsoni*, and the base was finely and densely striate; *perstriata* was considered as a locally abundant "mutation" which occurred sporadically throughout the species' range. In *percostata*, the riblets of the upper surface continued onto the base, which was strongly rib-striate.

Branson (1959), in a general discussion of the biotic divisions of Oklahoma, stated that *P. dorfeuilliana* tended to break into

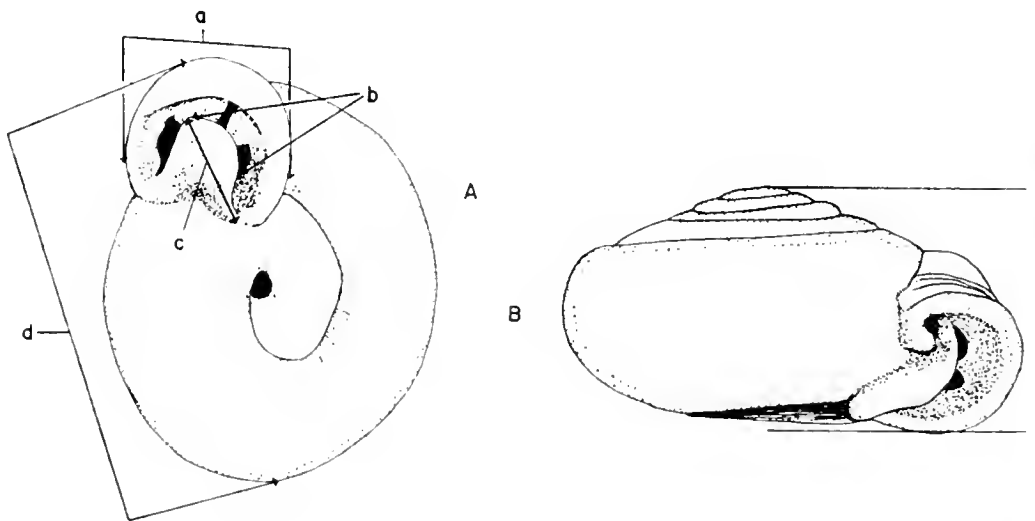


Figure 2. Shell dimensions selected for evaluation in *Polygyra dorfeuilliana*. A, basal view: a, diameter aperture; b, width parietal tooth; c, length parietal tooth; d, shell diameter; B, shell height.

many local populations, and he considered the form *sampsoni* to be an adaptive response to habitats in wooded ravines along stream margins; *percostata* was more or less typical of the Quachita Mountains (Lower Carolinian); and *perstriata* ranged along the western Ozarks. Three years later, after studying large series of shells, Branson (1962) wrote: "Specimens with the characters of the various "subspecies" can be found throughout the range of the species, and thus are largely imaginary. *Polygyra d. sampsoni* and *P. d. perstriata* should be relegated to the synonymy of *P. dorferilliana*."

Thus, this is the state of knowledge in *Polygyra dorfeuilliana*, and most of it is based upon judgments rather than actual investigation. Over the years, many arguments have been advanced concerning local molluscan populations ("microgeographical races," or "infraspecies," *auct*). Since certain aspects of these arguments are germane to the present work, they are briefly reviewed here.

Some time ago, working with insular (Hawaii, Societies, etc.) representatives of the Achatinellidæ and Partulidæ, Clench (1954) noted that minor changes in shell morphology and coloration occur from one mountain ridge and valley to another, and he considered such variation as developed clines. This same type of variation can be noted in polygyrid snails of the Rocky Mountains in the United States (See Pilsbry's 1940-1946 monographs). It is these local "microgeographical races" which many authors in the past have described as species or subspecies. In this regard, Burch and Thompson (1958) were of the opinion that many mollusks tend to form large numbers of local populations isolated because of sedentary habits and wide distribution. Such populations may be morphologically distinguished from one another, and their characters either genetically determined or ecophenotypically conditioned. Moreover, genetically independent characters do not necessarily vary gradually from one extreme to another at opposite ends of clines, although definite steps may be obvious along the variation gradient (Edwards, 1954; 1956). This morphological variation may be correlated with environmental influence upon genetically fixed characters. In the opinion of Hubendick (1951), all of these populations and microgeographical races comprise the entity termed "species," and it is absurd to favor each of them with subspecific epithets.

Clarification of the systematics at the subspecific level depends upon understanding the type and extent of variation which occurs in the characteristics normally utilized to recognize and describe the so-called races. In the Polygyridæ, these characteristics are at present conchological. It is the purpose of this investigation to demonstrate multi-directional variation in the shell of *Polygyra dorfeuilliana* correlated with geography, and to show the difficulty of recognizing definitive races within the species based upon such characters.

METHODS

Shells from live and dead specimens were secured from 40 localities in five population centers (Fig. 1), representing a large number of local conditions. Six mensurable conchological features (Figs. 2,3) and four indices (figs. 9,10,11,12) were compared. This technique was utilized by Richards and Ferguson (1965) in *Australorbis*.

Measurements were made by means of needle-nosed calipers and a steel metric scale calibrated to 0.5 mm, and estimations were made to 0.1 mm. Whorl number was determined by making camera lucida sketches of shells, following which measurements were made by means of a polarizing planimeter.

Statistical evaluation of data, range, mean, standard deviation, standard error, and coefficient of variation, follows Snedecor (1956), and data-graphing follows Hubbs and Hubbs (1953). In general, it is probably safe to assume that when the black bars derived from the data of various populations do not overlap that the difference between means is not due to chance alone but represents actual differences between populations.

Population Sampling Areas

For the purpose of analysis (variation associated with geography) eastern Oklahoma was divided into four regions (Fig. 1), with some samples coming from adjacent Arkansas and Missouri, based upon natural geographic phenomena. These are listed below with the collecting data for specimens secured in each region.

Area A. The Arbuckle Mountains form a low dissected plateau sloping gently toward the southeast (Weidman, 1922). The somewhat triangular plateau, from 1300 feet elevation in the west to 750 feet in the east, encompasses about 800 square miles. Usually,

only the highest part west of the Washita River in Murray county, Oklahoma, is referred to as the Arbuckles, and it was from this region that my samples were collected. Surrounding the older rocks of the plateau are Pennsylvania and Permian strata some 100 to 200 feet lower. The mountains are more or less surrounded by plains.

Collecting sites: (a.) 29 February 1964; 31 specimens, 0.5 mile north of main gate, Platt National Park, Murray county, Oklahoma. (b.) 29 February 1964; 69 specimens, Ordovician talus, 6.1 miles south of Turner Falls, U.S. Highway 77, Carter County, Oklahoma. N = 100 utilized.

Area B. The so-called Osage Biotic District of Blair and Hubbell (1938) is a rather distinct subdivision of Dice's (1943) Texan Province. The physiography is uneven, with low rounded hills and some eroded ridges. The dominant vegetation is tall grasses and oak-hickory associations.

Collecting sites: (a.) 28 August 1963; 67 specimens; 0.8 mile north of Childers, U.S. Highway 60, Nowata County, Oklahoma. (b.) 28 August 1968; 193 specimens; 4 miles east of Nowata, U.S. Highway 60, Nowata County, Oklahoma. (c.) 13 September 1963; 44 specimens; 0.5 mile east of Keystone Dam, Arkansas River Bluffs, old Oklahoma State Highway 51, Tulsa County. (d.) 27 August 1963; 5 specimens; Sand Creek Bluffs, Osage Hills State Park, Osage County, Oklahoma; (e.) 25 August 1963; 12 specimens; bluffs overlooking a small pond near main entrance, Osage Hills State Park, Osage County, Oklahoma. N = 321 utilized.

Area C. The Ozark District, sharply separated from the Osage by the Cherokee Plains, and the flood plains of the Neosho River, is a more or less well-known uplift of mainly Mississippian and Pennsylvanian rocks. To the south these mountains are bordered by plains scarcely 100 feet above sea level, and are separated from Area D. by the broad valley of the Arkansas River.

Collecting sites: (a.) 24 August 1963; 1 specimen; Neosho River bluffs, Cherokee Recreation Area #1, Langley, Mayes County, Oklahoma. (b.) 17 May 1964; 5 specimens; 3 miles east of Pineville, U.S. Highway 71, McDonald County, Missouri. (c.) 26 August 1963; 8 specimens; 5 miles east of Pineville; (d.) 26 August 1963; 35 specimens; near Disney Dam, Oklahoma Highway 20, Mayes County. (e.) 4 April 1963; 7 specimens; 7.4 miles

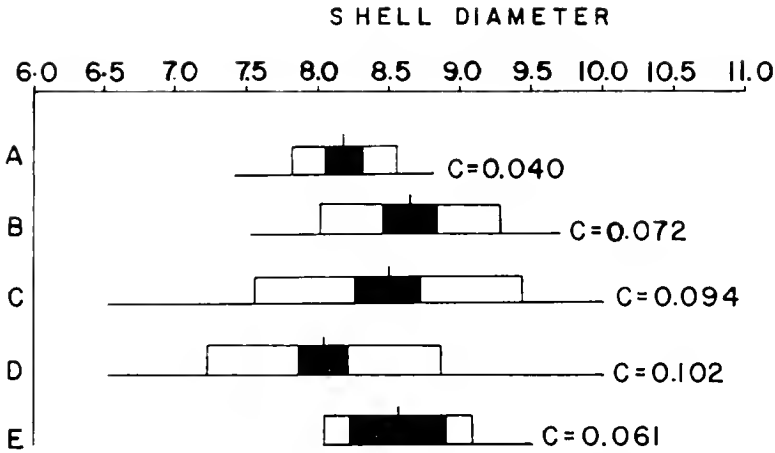


Figure 3. Shell diameter in five populations of *Polygyra dorfeuilliana*. Letters on vertical axis correspond to populations delimited in text. c = coefficient of variation. Measurements in mm. Black bar = two standard errors on each side of mean; hollow bar = one standard deviation on each side of mean;

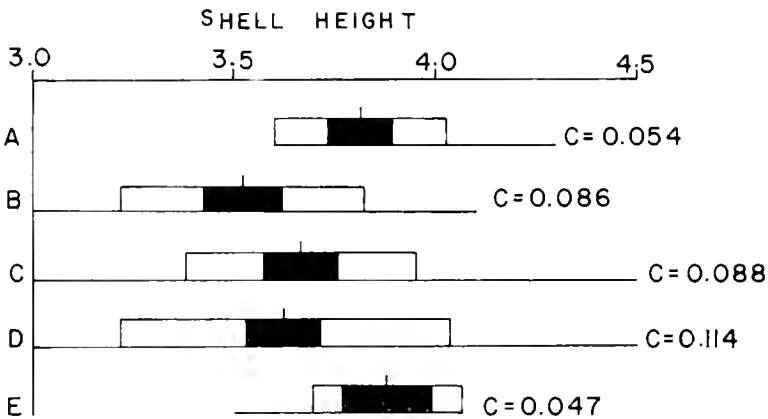


Figure 4. Shell height in five populations of *Polygyra dorfeuilliana*. Abbreviations and incidentals as in figure 3.

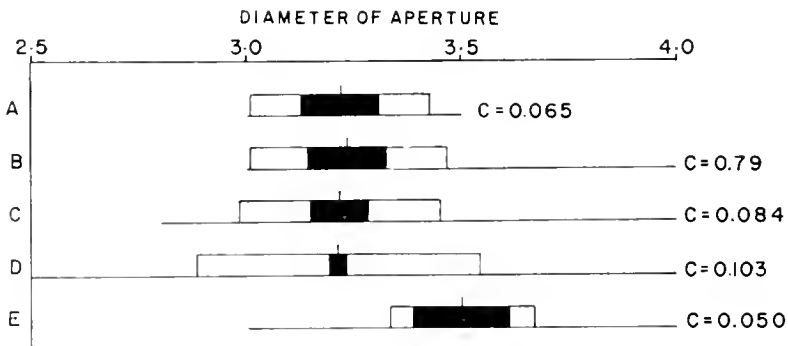


Figure 5. Apertural diameter in five populations of *Polygyra dorfeuilliana*. Abbreviations and incidentals as in figure 3.

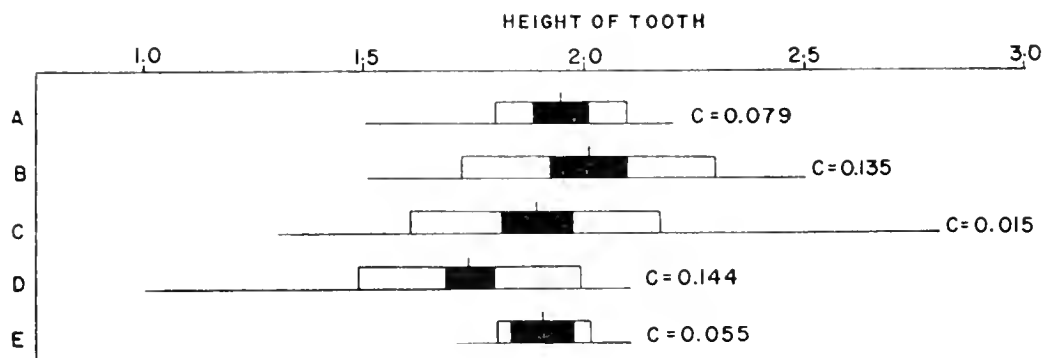


Figure 6. Height of parietal tooth in five populations of *Polygyra dorfeuilliana*. Abbreviations and incidentals as in figure 3.

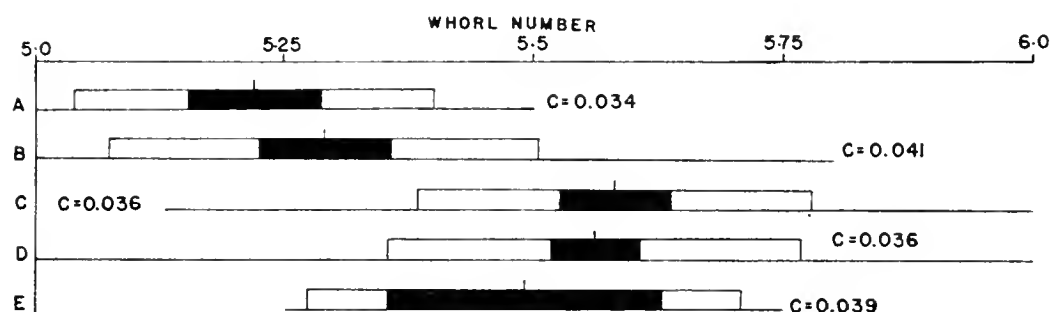


Figure 7. Width of parietal tooth in five populations of *Polygyra dorfeuilliana*. Abbreviations and incidentals as in figure 3.

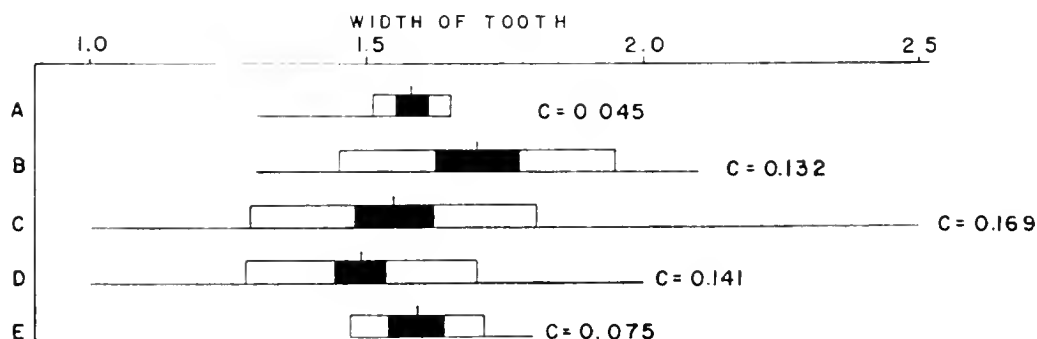


Figure 8. Whorl number in five populations of *Polygyra dorfeuilliana*. Abbreviations and incidentals as in figure 3.

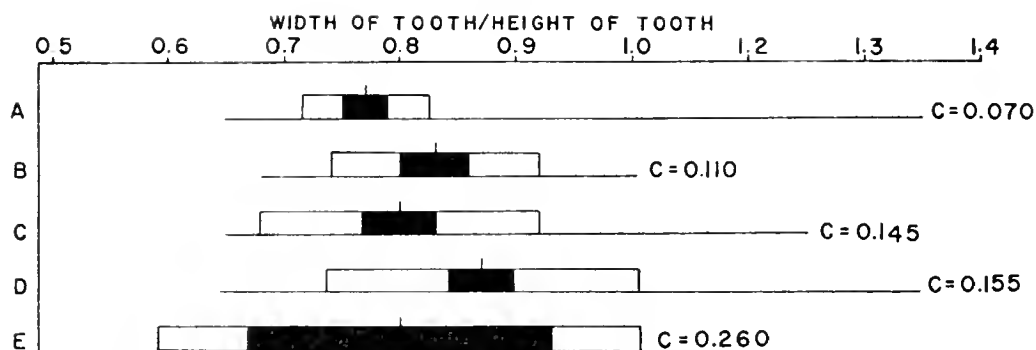


Figure 9. Width of parietal tooth/Height of parietal tooth in five populations of *Polygyra dorfeuilliana*. Abbreviations and incidentals as in figure 3.

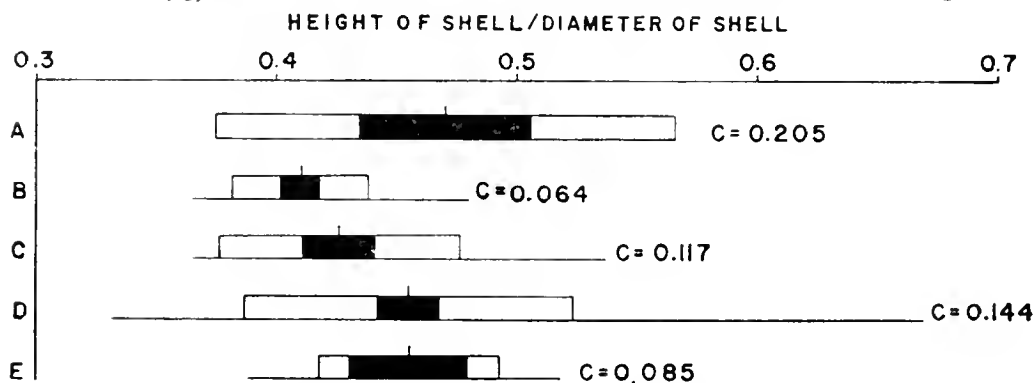


Figure 10. Height of shell/Diameter of shell in five populations of *Polygyra dorfeuilliana*. Abbreviations and incidentals as in figure 3.

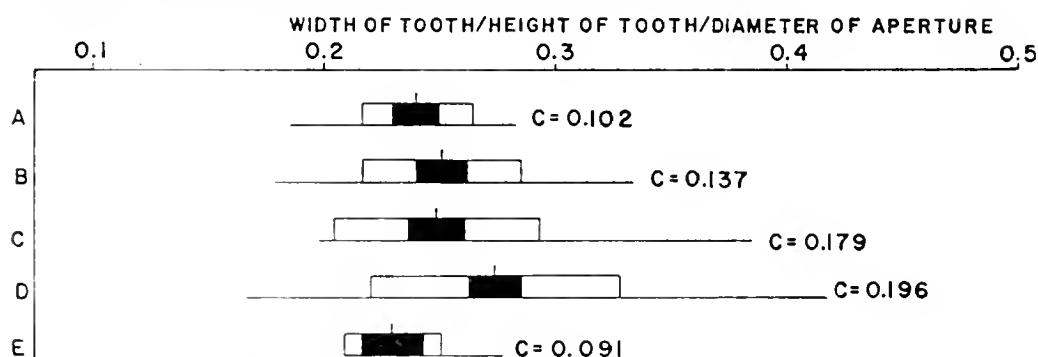


Figure 11. Width of parietal tooth/Height of parietal tooth/Diameter of aperture in five populations of *Polygyra dorfeuilliana*. Abbreviations and incidentals as in figure 3.

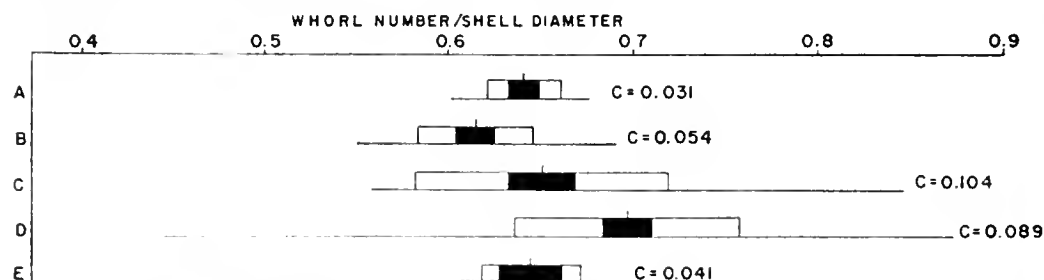


Figure 12. Whorl number/Shell diameter in five populations of *Polygyra dorfeuilliana*. Abbreviations and incidentals as in figure 3.

east of junction of Oklahoma Highways 259 and 59, Adair County. (f.) 25 August 1963; 11 specimens; 5.5 miles east of Salina, Oklahoma Highway 82, Mayes County. (g.) 26 June 1963; 7 specimens; 1 mile south of Lanagan, U.S. Highway 71, McDonald County, Missouri. (h.) 24 August 1963; 40 specimens; east end Tenkiller Dam, Sequoyah County, Oklahoma. (i.) 26 August 1963; 10 specimens; hills above Spavinaw Creek, Spavinaw, Mayes County, Oklahoma. (j.) 21 September 1963; 25 specimens; 0.1 mile north, 2 miles east of Turkey Ford, Delaware County, Oklahoma. (k.) 24 August 1963; 66 specimens; west side of Tenkiller Dam, Sequoyah County, Oklahoma. (l.) 13 May 1963; 28 specimens; Lanagan, McDonald County, Missouri. (m.) 20 August 1963; 114 specimens; 15 miles east of Cassville, Missouri. (n.) 4 June 1963; 3 specimens; 7.4 miles east of Jet, Adair County, Oklahoma. (o.) 25 August 1963; 4 specimens; 1.2 miles east of Flint, Delaware County, Oklahoma. (p.) 16 May 1963; 3 specimens; Lost Creek, 15 miles southeast of Miami, State Highway 10, Ottawa County, Oklahoma. N = 246 utilized.

Area D. Quachita Mountains. As indicated, these mountains are separated from the Ozarks by the Arkansas River valley to the north, and they are bordered southward by the Austroriparian lowlands, and in the west by plains.

Collecting sites: (a.) 31 May 1963; 12 specimens; 3 miles south of Foreman, Sevier County, Arkansas. (b.) 22 August 1963; 9 specimens; 0.5 mile east, 1.5 miles north of Muse, Oklahoma Highway 63, LeFlore County, Oklahoma ("Billy Creek Recreation Area"). (c.) 23 August 1963; 3 specimens; Robbers Cave State Park, 5 miles north of Willburton, Latimer County, Oklahoma. (d.) 18 August 1963, Windingstair Mountain, 0.5 mile from junction of Oklahoma Highways 59 and 259, LeFlore County, Oklahoma. (e.) 21 August 1963; 91 specimens; Lake Talihina, 2 miles west of Talihina, Latimer County, Oklahoma. (f.) 21 August 1963; 7 specimens; Kiamichi Mountain, 0.9 mile north of Honobia, Pushmataha County, Oklahoma. (g.) 22 August 1963; 11 specimens; 26.6 miles south of Hartshorn, Jackfork Mountain, Pittsburg County, Oklahoma; (h.) 19 August 1963; 24 specimens; 1.4 miles southeast of Monroe, Oklahoma Highway 83, Poteau Mountain, LeFlore County. (i.) 21 August 1963; 45 specimens; 1 mile west of Kiamichi fire tower, Kiamichi Mountain, LeFlore

County, Oklahoma. (j.) 21 August 1963; 79 specimens; Potatoe Hills (Flying "W" Ranch), 5 miles west of Talihina, Oklahoma Highway 83, Latimer County, Oklahoma. (k.) 22 August 1963; 55 specimens; Blue Mountain, Holson Valley Road (Branch off State 271), LeFlore County, Oklahoma. (l.) 20 August 1963; 5 specimens; 0.7 mile south of Page, Oklahoma Highway 259, LeFlore County, Oklahoma. (m.) 23 August 1963; 63 specimens; Cavanal Mountains, 2 miles west of Poteau, LeFlore County, Oklahoma. (n.) 23 August 1963; 46 specimens; 5.3 miles north of Wilburton, Oklahoma Highway 2, Latimer County. (o.) 19 August 1963; 35 specimens; 1.4 miles southeast of Monroe, Oklahoma Highway 83, Poteau Mountain, LeFlore County. (p.) 19 August 1963; 15 specimens; Walker Mountain, 11.1 miles east, 2.8 miles south of Page, LeFlore County, Oklahoma. N = 618 utilized.

Area E. Plains between Quachitas and Arbuckles.

Collecting sites: (a.) 27 August 1963; 63 specimens; Rock Creek Bluffs, 2 miles south of Eufala, U.S. Highway 69, McIntosh County, Oklahoma. (b.) 27 August 1963; 133 specimens; 19 miles north of Atoka, U.S. Highway 69, Atoka County, Oklahoma. N = 196 utilized

RESULTS

Comparison of shell diameters in the series of *P. dorfeuilliana* demonstrated considerable variation (Fig. 3), with the smallest shells coming from the Arbuckles and the largest ones from the Ozarks and Quachitas. Comparison of the means possibly indicates the presence of a weakly developed cline extending from the more arid regions toward the east (particularly if the data gleaned from population E is lumped with that from D): A . . . B . . . C . . . D (E). In the field, specimens from area A appeared smaller than those secured elsewhere. Moreover, shell-height differences were obvious by inspection.

Shell heights (Fig. 4) varied rather greatly, but there is only slight to no overlap in the means of populations A and E with the means of shells taken from other regions, thus indicating a tendency for shells to become more elevated in the southern part of the range. The ratio height/diameter (Fig. 10) reflects the flatter shells from areas B and C and a trend toward intermediacy in ones from area D.

In snails with indeterminate growth patterns, as in *Polygyra*, total diameter is obviously a function of whorl number. However, the thickened flange (lip) produced at the aperture of most polygyrids also influences the diameter. Whorl number varies within a rather narrow spectrum (Fig. 7) after the lip is produced. It will be noted that western specimens (with no overlap) tend to produce from a quarter to one-half less whorl than more easterly populations. When whorl number is viewed as a percentage of the total diameter (Fig. 12) a similar picture emerges, but the populations tend to smooth-out somewhat.

In general, although the range of variation was considerable, there seemed to be little difference between the means of apertural diameters (Fig. 5), except in specimens from area E. Deviations in this population were significant at the 0.01 level (student "t" distribution). Within the aperture are two deeply immersed lip denticles ("teeth"), and standing in front of the aperture, often nearly blocking it, is a tongue-like parietal tooth (Fig. 2) which varied from 1.0 mm to 3.0 mm in height, being significantly shorter in shells secured in region D (Fig. 6). The width of this denticle (Fig. 8) is also variable, but there does not appear to be much difference between the means of the various groups investigated. The ratio width of tooth/height of tooth (Fig. 9) demonstrates the same type of variation in range, but no significant differences among means; the variation is concordant. On the

other hand, the ratio
$$\frac{\text{width of tooth/height of tooth}}{\text{diameter of aperture}}$$
 again indi-

cates a significant difference in specimens from area D. In other words, consistent differences in the form of the parietal tooth seem to be correlated with those observed in the aperture.

DISCUSSION

Most of the variable characteristics described above are considered parameters of microgeographical races, and many of them are probably genetically determined, although some traits may be ecophenotypic responses to local conditions. It is possible, when observing only one or a few mensurable characters, to show non-overlap in mean differences, and hence one might be tempted to assign a given population a subspecific epithet. This is apparent

in shells collected from area D. However, more characteristics overlap than not. Furthermore, when features other than those discussed above are observed, such as external sculpture and coloration, specimens from area A (especially from the Osage region) are more strikingly different than ones from area D. In my estimation, then, to reiterate a previous statement, the subspecies of *Polygyra dorfeuilliana*, as such, are fictional. Looking at samples secured from widely separated regions may seem to indicate real differences, but when these differences are subjected to scrutiny, they are seen to be only discordant variation associated with the sedentary habits of the snail.

SUMMARY

Detailed morphologic analyses were performed on 1,481 shells of *Polygyra dorfeuilliana* secured from 40 localities in five major population centers in Oklahoma, Missouri and Arkansas. Such characters show considerable variation, some of them (shell diameter and height) seem to vary clinally from west to east and north to south, respectively. Other characteristics, whorl number, apertural diameter, and the ratio $\frac{\text{width of parietal tooth/height of parietal tooth}}{\text{diameter of aperture}}$

show consistent differences between some populations. These are considered to be examples of discordant variation.

LITERATURE CITED

- Blair, W. F. and T. H. Hubbell. 1938. The biotic districts of Oklahoma. Amer. Midl. Nat. 20: 425-454.
- Branson, B. A. 1959. The Recent Gastropoda of Oklahoma. Part 1, historical review, general comments and higher taxonomic categories. Proc. Oklahoma Acad. Sci. 39: 21-37.
- Branson, B. A. 1962. The Recent Gastropoda of Oklahoma, Part IV. Terrestrial species, families Polygyridæ and Bulimulidæ. Proc. Oklahoma Acad. Sci. 42: 60-80.
- Burch, J. B. and F. G. Thompson. 1958. Taxonomic characters and infraspecific variation in Mollusks. Syst. Zool. 7: 48.
- Clench, W. J. 1954. The occurrence of clines in molluscan populations. Syst. Zool. 3: 122-125.
- Dice, L. R. 1943. *The Biotic Provinces of North America*. Univ. Mich. Press, Ann Arbor, 78p.
- Edwards, J. G. 1954. A new approach to infraspecific categories. Syst. Zool. 3: 1-20.

- Edwards, J. G. 1956. Clarification of certain aspects of infraspecific systematics. *Syst. Zool.* 5: 92-94.
- Hubbs, C. L. and Clark Hubbs. 1953. An improved graphical analysis and comparison of series of samples. *Syst. Zool.* 2: 49-56; 92.
- Hubendick, B. 1951. Recent Lymnæidæ, their variation, morphology, taxonomy, nomenclature, and distribution. *Kungl. Svenska Vetenskad. Handl.* 3: 1-223; 5 pl.
- Pilsbry, H. A. 1940. Land Mollusca of North America (North of Mexico). *Acad. Nat. Sci. Philadelphia Mongr.* 3 (2): i-viii; 575-994; i-ix.
- Pilsbry, H. A. and J. H. Ferriss. 1906. Mollusca of the Ozarkian fauna. *Proc. Acad. Nat. Sci. Philadelphia* 1906: 529-567.
- Richards, C. S. and F. T. Ferguson. 1965. Variability in *Australorbis glabratus* (Say). *Trans. Amer. Micros. Soc.* 84: 580-587.
- Snedecor, G. W. 1956. *Statistical Methods*. Iowa State College Press, Ames.
- Weidman, S. 1922. Physiographic history of the Arbuckle Mountains. *Proc. Okla. Acad. Sci.* 2: 74-77.

LATIRUS VARAI, A NEW FASCIOLARIID GASTROPOD FROM THE CARIBBEAN

By ROBERT C. BULLOCK

Museum of Comparative Zoology, Harvard University
Cambridge, Massachusetts 02138

Species of the genus *Latirus* (Gastropoda: Fasciolariidae), though well represented in the West Indian faunal province, are not commonly collected alive. The numerous taxonomic problems that exist within the group are related to the considerable intraspecific variation of each species. In a recent study of the genus *Latirus* of the western Atlantic (Bullock, 1968), a new species was noted and is herein described:

LATIRUS (LATIRUS) VARAI, new species (Figure 1)

Description: Shell large, up to 70 mm in length and 27.8 mm in greatest diameter. Spire slightly higher than half the length of the shell. Whorls 10, including 2 whorls of the protoconch. Aperture squarish in the mature specimen examined and about the same length as the siphonal canal. Axial sculpture of 7-8 ribs per whorl and numerous fine growth lines. Spiral sculpture of

13-15 cords which are more pronounced as they pass over the axial ribs. 9-11 spiral cords on the upper whorls. Columella with 4 folds, the upper one weaker than the others. Outer lip slightly crenulate, with about 15 irregular, sometimes beaded, lirae running into the aperture. Fasciole well developed, pseudo-umbilicus slit-like. Periostracum unknown.

Shell white to tawny brown in the areas of the sutural ramp and the neck. Axial ribs light chestnut brown and crossed by white spiral cords. Aperture white.

Measurements: Holotype 70.0 mm in length, 27.8 mm in greatest diameter; Paratype (also from the type locality) 52.4 mm in length.

Type locality: Off Gibara, Oriente Province, Cuba in 100 fathoms.

Type depositories: Holotype, Museum of Comparative Zoology, Harvard University 262589; paratype in the collection of Mr. John Finlay of Wilmington, Delaware (both types collected dead).

Remarks: This species is unlike any other West Indian *Latirus*. The only other member of *Latirus* s.s. from the Caribbean is the highly variable *Latirus distinctus* A. Adams, 1855 (= *Turbinella trochlearis* Kobelt, 1874; *L. mcgintyi* Pilsbry, 1939; and possibly *Fusus cariniferus* Lamarck, 1816). *L. varai* may easily be distinguished from *L. distinctus* by its stronger spiral sculpture, more rounded whorls, and especially by its possession of the chestnut brown coloration on the axial ribs, not between them. In comparison with other species, *L. varai* appears to be related to *Latirus kandai* Kuroda, known only from Kii Peninsula, Honshu, Japan (Habe, 1964).

This species is named in honor of Senor Joaquín de la Vara of Gibara, Oriente Province, Cuba, who collected the specimens.

ACKNOWLEDGMENTS

Both specimens of *L. varai* belonged to Mr. John Finlay of Wilmington, Delaware, who kindly donated the holotype to the Museum of Comparative Zoology. My dissertation of western Atlantic *Latirus* was done under the direction of Dr. John H. Dearborn and presented to the Zoology Department of the University of Maine at Orono, for partial fulfillment of the requirements of the Master of Science degree.

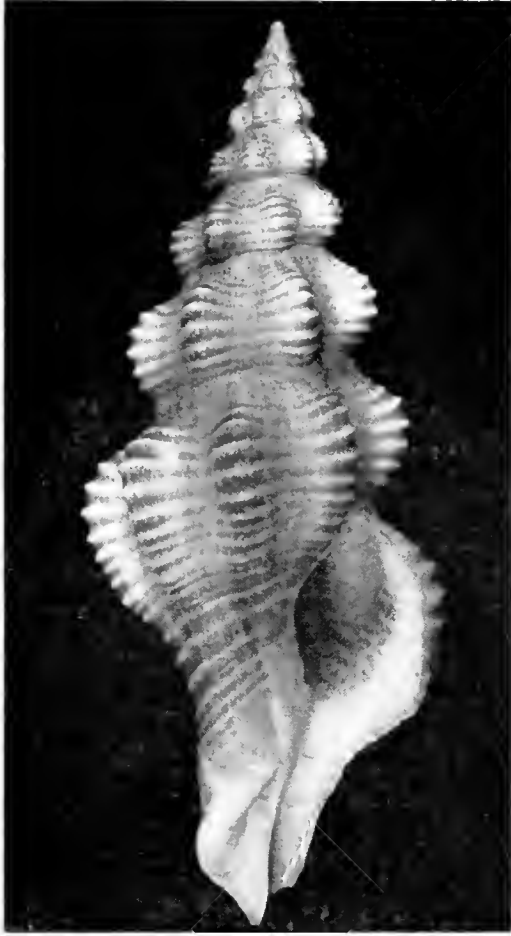


Figure 1. *Latirus (Latirus) varai* Bullock, new species. Holotype, off Cuba. Length: 70 mm.

REFERENCES CITED

- Adams, A. 1855. Descriptions of twenty-seven new species of shells from the collection of Hugh Cuming, Esq. Proc. Zool. Soc. London for 1854: 311-317.
- Bullock, R. C. 1968. The fasciolariid genera *Latirus*, *Dolicholatirus*, and *Teralatirus* (Mollusca: Gastropoda) in the western Atlantic. Unpublished M.S. thesis, University of Maine, 109 p., 8 pls., 2 figs.
- Habe, T. 1964. Shells of the Western Pacific in Color, 2. Osaka, 233 p., 66 pls.
- Kobelt, W. 1874. *Turbinella* and *Fasciolaria* [in] Martini-Chernitz, Systematisches Conchylien-Cabinet, 3 (3A): 65-88, pls. 8, figs. 17-21.
- Lamarck, J. 1816. Tableau encyclopédique et méthodique des trois règnes de la nature. Paris, 97 pls.
- Pilsbry, H. A. 1939. A triad of umbilicate *Latirus*, Recent and Pliocene. Nautilus, 52 (3): 84-86, 1 pl.

MAINTENANCE OF LAND MOLLUSKS IN THE LABORATORY

By W. PATRICK CARNEY

Department of Zoology, University of Montana
Missoula, Montana 59801

Since molluscan hosts of medically important trematodes are predominantly aquatic, most accounts of snail raising relate to aquatic snails. Only recently has the importance of land snails as vectors for human or domestic animal helminths been realized. Terraria and techniques for the cultivation of land snails have been developed by numerous workers (Carmichael, 1937; Archer, 1937; Krull, 1937; Denton, 1944; Peterson, 1947; Webb, 1947; Tang, 1950; Mapes and Krull, 1951; Ulmer, 1951; Patten, 1952; Rowan, 1955; Pillmore, 1958; Hohorst and Lämmler, 1962; Forrester, 1962; Kingston, 1965; Kingston, 1966). Because of the growing recognition of zoonotic diseases involving land snail hosts, additional techniques for laboratory maintenance of land molluscs

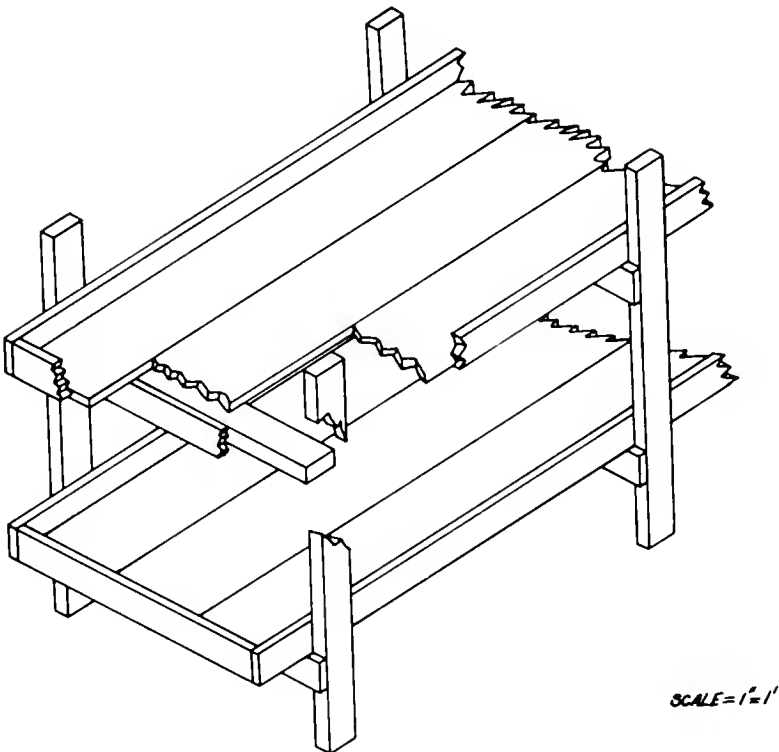


Figure 1. Basic water table construction. Each level was lined with plastic. Water was then allowed to flow onto the table to a depth of approximately 2". The siphon apparatus in Figure 2 maintained a constant water level.

should be of interest. The methods described below for raising a variety of land mollusks in large numbers have the advantages of being inexpensive and requiring a minimum of maintenance. Colonies were maintained in a basement laboratory provided with a floor drain. Temperature control was achieved by utilizing a shallow, plastic-lined water table of approximately 150 square feet of surface and one to two inches deep (Figure 1). City water, normally varying in temperature from 9°C to 15°C, was allowed to flow slowly onto the water table. A glass siphon apparatus (Figure 2) kept the water level constant barring extreme variations in pressure.

Snails were bred and raised in various types of plastic containers available in local stores for domestic use. Most of these were either round, shallow tubs approximately 12 inches in diameter or rectangular and square boxes 6-12 inches on a side. Each container held one inch of moist sand, serving as a source of minerals and as a site for egg laying. One or two layers of damp laboratory paper towelling covered the sand. The containers were immersed to a depth of one-two inches in the water bath. For breeding and cul-

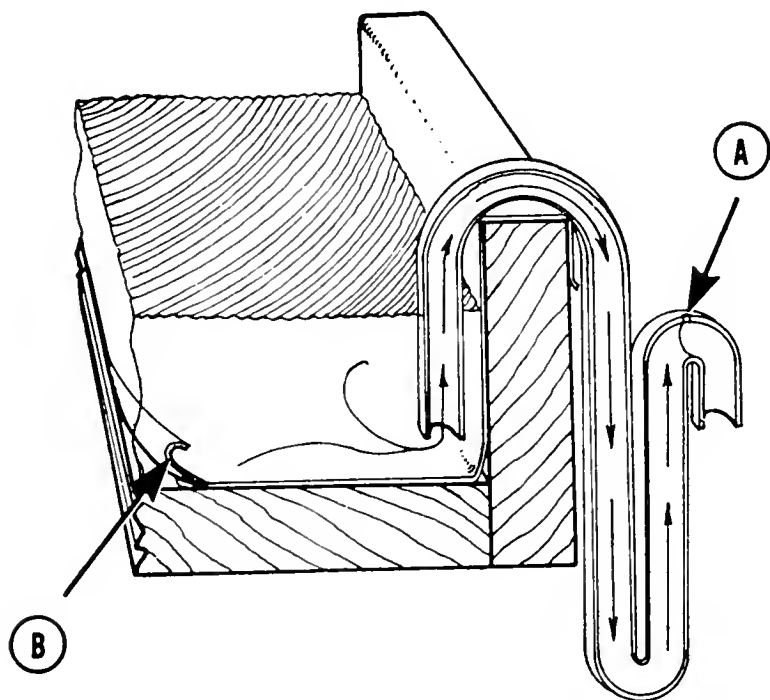


Figure 2. Glass siphon apparatus which maintains a constant water level on water table at a level parallel with point (A). The plastic lining is indicated at (B).

ture of *Allogona ptychophora* and *Triodopsis mullani*, two previously soaked pumice bricks were placed on the paper towelling. The container was then closed with a one-ply glass lid. For smaller snails, *Discus cronkhitei*, *Zonitoides arboreus*, and *Z. nitidus* and the slugs *Deroceras laeve* and *D. reticulatum* decaying wood was substituted for pumice bricks. All species were fed lettuce and carrots sparingly. Occasionally a piece of chalk was added for calcium supply. Containers were inspected at least once each week at which time the paper towelling was changed, old food removed, and fresh food provided.

Although their shells never attained the thickness of those collected in the field. Laboratory raised *Allogona ptychophora* reached maturity and attained normal size in one year. The thin shells of laboratory raised specimens, although quite fragile, proved an advantage in studies of trematode infections since the hepatopancreas could be observed through the shell. Laboratory and natural raised specimens of *T. mulloni*, *D. cronkhitei*, *Z. arboreus* and *Z. nitidus* showed no significant difference in shell thickness.

Acknowledgements: Appreciation is extended to Dr. Glen R. Webb for his comments, and to Richard Russell and Sharon Carney for their technical assistance.

REFERENCES

- Archer, A. F., 1937. Civilization and land mollusks in Ohio. *Nautilus* 50: 117-121.
- Carmichael, E. B., 1937. Culture methods for *Limax flavus*. pp. 529-531. In J. G. Needham (ed.), *Culture methods for invertebrate animals*. Dover Publications, Inc., New York.
- Denton, J. F., 1944. Studies on the life history of *Eurytrema procyonis* Denton, 1942. *J. Parasitol.* 30: 277-286.
- Forrester, D. J., 1962. Land mollusca as possible intermediate hosts of *Protostrongylus stilesi*, a lungworm of bighorn sheep in western Montana. *Proc. Mont. Acad. Sci.* 22: 82-92.
- Hohorst, W. and G. Lämmler, 1962. Experimentelle Dicrocoeliose-Studien. *Z. Tropenmed. Parasit.* 13: 377-397.
- Kingston, N., 1965. On the life cycle of *Brachylecithum orfi* Kingston and Freeman, 1959 (Trematoda: Dicrocoeliidae), from the liver of the ruffed grouse, *Bonasa umbellus* L. Infections in the vertebrate and molluscan hosts. *Can. J. Zool.* 43: 745-766.
- , 1966. Observations on the laboratory rearing of terrestrial molluscs. *Am. Midl. Natur.* 76: 528-532.
- Krull, W. H., 1937. Rearing terrestrial snails. pp. 526-527. In J. G.

- Needham (ed.), Culture methods for invertebrate animals. Dover Publications, Inc., New York.
- Mapes, C. R. and W. H. Krull, 1951. Collection of the snail, *Cionella lubrica*, and its maintenance in the laboratory. Cornell Vet. 41: 433-444.
- Patten, J. A., 1952. The life cycle of *Conspicuum icteridorum* Denton and Byrd, 1951 (Trematoda: Docrocoeliidae). J. Parasitol. 38: 165-182.
- Peterson, A., 1947. A manual of entomological equipment and methods. Edwards Brothers Inc., Ann Arbor, Mich. (c.f. Rowan, 1955).
- Pillmore, R. E., 1958. Life cycles of the lungworm genus *Protostrongylus* in Colorado. J. Colo. - Wyo. Acad. Sci. 4: 44-45.
- Rowan, W. B., 1955. The life cycle and epizootiology of the rabbit trematode, *Hasstilesia tricolor* (Stiles and Hassall, 1894) Hall, 1916 (Trematoda: Brachylaemidae). Trans. Am. Microscop. Soc. 74: 1-21.
- Tang, C. C., 1950. Studies on the life history of *Eurytrema pancreaticum* Janson, 1889. J. Parasitol. 36: 559-573.
- Ulmer, M. J., 1951. *Postharmostomum helici* (Leidy, 1847) Robinson, 1949 (Trematoda), its life history and a revision of the subfamily Brachylaeminae. Part I. Trans. Am. Microscop. Soc. 70: 189-238.
- Webb, G. R., 1947. The mating-anatomy technique as applied to polygyrid landsnails. Amer. Naturalist 81: 134-147.
-

HISTOLOGICAL STUDIES OF THE NEPHRIDIUM AND PERICARDIAL LINING OF QUADRULA NODULATA

BY PAUL ROBERT MYERS AND DOROTHEA S. FRANZEN

Illinois Wesleyan University, Bloomington, Illinois 61701

The mechanism of excretion of the pelecypod excretory system is not yet fully understood. It is the intention of the authors of this paper to contribute to the knowledge of this system. Although data concerning the organic and inorganic nature of the excretory products are available (Picken, 1936), the actual cellular processes are still seemingly unexplored. Duwe (1948) has contributed a limited histological description of the nephridium. Through the employment of histological and histochemical techniques an attempt has been made here to provide information regarding the processes involved in excretion.

MATERIALS AND METHODS

Quadrula nodulata (Rafinesque, 1820) is a small freshwater clam averaging 3.2 cm. in length, inhabiting a sandy to rocky bottom in shallow water. The specimens for this study were collected in the Mississippi River eight miles north of Quincy, Illinois. Specimens were removed from their shells by severing the adductor muscles and gently removing the viscera from the shell. Immediately the clams were fixed in Zenker's or Heidenhein's Susa fixatives to minimize histological changes. Chemical fixation, embedding by the paraffin method, and sectioning were by standard procedures. Histological sections were cut six microns in thickness and stained with Mallory's Triple Stain, Heidenhein's Azan Stain or Alum Hematoxylin and Eosin Stain according to methods outlined by Galigher (1964).

OBSERVATIONS

Each of the laterally paired nephridia of the clam is shaped like a U lying on one side with the open end facing anteriorly. The ventral stem of the U opens anteriorly into the pericardial cavity to form the ciliated nephrostome. Laterally and slightly posterior to the nephrostome, the dorsal portion of the U opens into the suprabranchial chamber to form the nephridiopore (Fig. 1).

The ventral portion of the nephridium is characterized by many involuting diverticula, thus accounting for the glandular, spongy appearance seen in gross dissection. Its epithelium is of the simple columnar type. The dorsal portion lacks the diverticula and forms a sac-like structure whose epithelium is of a more cuboidal type. This sac is histologically and morphologically quite unlike the ventral, glandular portion, suggests the function of a bladder, and opens anteriorly into the suprabranchial chamber via the ciliated nephridiopore. Dorsal to the bladder lies the reduced coelom, or pericardial cavity, enclosing the heart which is folded around the intestine. The pericardial lining is comprised of simple columnar epithelium. Surrounding the nephridium and pericardial cavity is a large blood sinus, the pericardial sinus, which contains loose connective tissue, tissue fluid, and blood cells (Fig. 1). Closely applied to the basal portion of the columnar epithelium are two layers of tissue, the innermost a simple squamous epithelium and the outermost a connective tissue layer. These two layers of tissue

separate the nephridium and pericardium from the pericardial sinus.

RESULTS

Histological study of the pericardial and nephridial tissues disclosed that three types of epithelial cells are apparently involved in excretion: (A) Most abundant are ciliated simple columnar

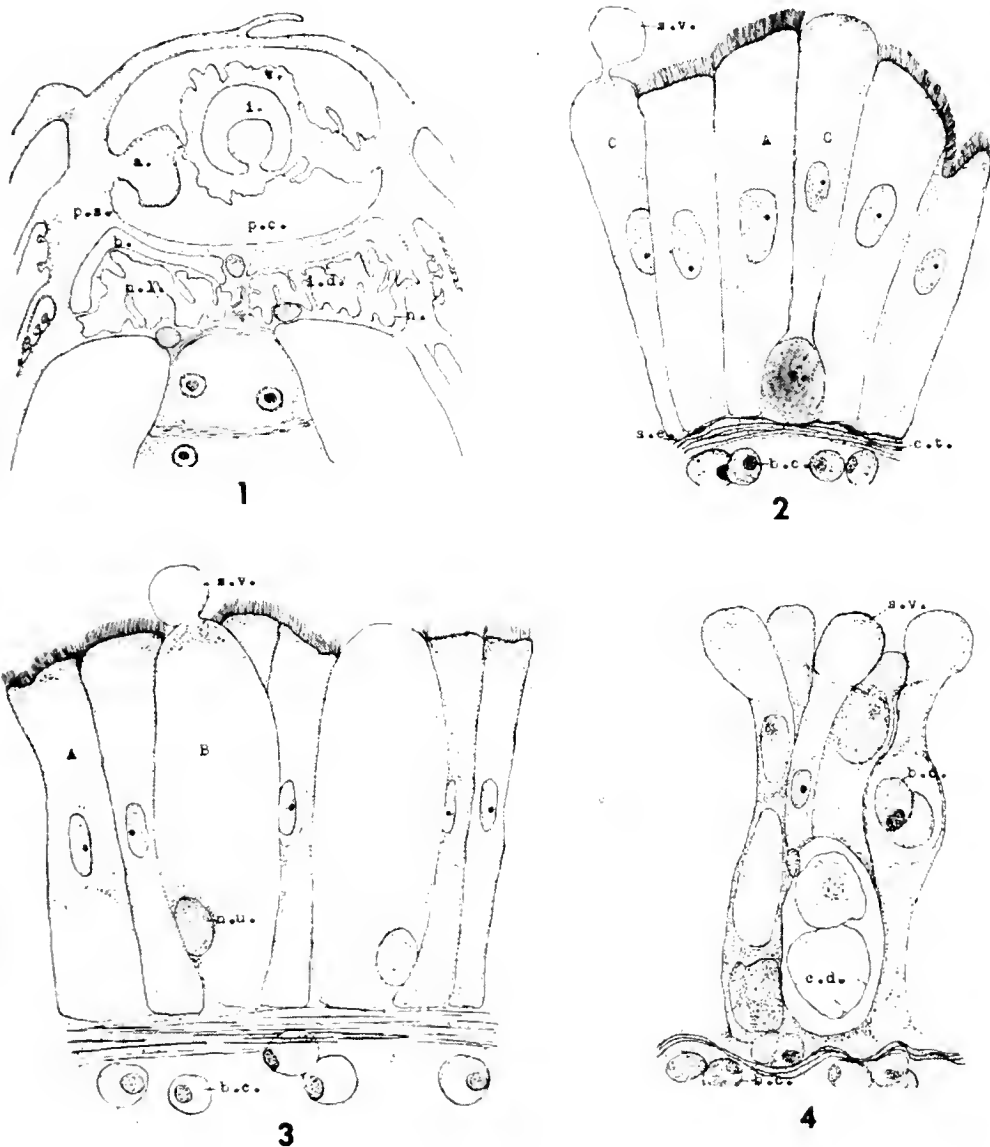


Fig. 1. Dorsal x-sec. through pericardial cavity and nephridium. a. auricle; b. bladder; i. intestine; n. nephridium; n.l. nephridial lumen; p.c. pericardial cavity; p.s. pericardial sinus; v. ventricle. Fig. 2. Lining of pericardial cavity. A. cell type A; b.c. blood cell; C. cell type C; c.t. connective tissue; s.e. squamous epithelium; s.v. secondary vesicle; v. vacuole. Fig. 3. Cells of nephridium. A. cell type A; B. cell type B; nu. nucleus. Fig. 4. Ventral portion of pericardial cavity. c.d. cellular debris.

cells which are noted as type A (Figs. 2 & 3). The cells contain a large, granular, centrally located nucleus with one or two nucleoli. These cells are interspersed at random in the nephridial epithelial tissue and pericardial lining where they, evidently, function in movement of material from the pericardial cavity or the lumen of the nephridium. This type cell lines also the nephridiopore and the nephrostome. (B) Another type cell also observed, noted as type B (Fig. 3), is columnar and contains a large, non-granular vacuole which displaces the cell's nucleus laterally and ventrally to a basal position. The cell appears mainly in the posterior region of the nephridium and occurs less frequently in the lining of the pericardial cavity. Further observation revealed constriction of secondary vesicles into the lumen of the nephridium or pericardial cavity. (C) Most relevant to the study is the presence of a non-ciliated, nucleate, columnar cell abundant both in the nephridial tissue and lining of the pericardium (Figs. 2 & 4). The cell is randomly interspersed between the other two cell types and, as mentioned earlier, is in close contact with the blood in the pericardial sinus. Constriction of secondary vesicles was observed similar to that observed in the type B cell.

DISCUSSION

On the basis of the above observations and results, three types of simple columnar epithelial cells are apparently involved in an excretory function. The very nature of the constriction of secondary vesicles suggests the mechanism of excretion. The cell types have been presented above as types A, B, and C.

Cell type A is ciliated. Its function is evidently movement of material from the pericardial cavity toward the lumen of the nephridium or from the lumen of the nephridium to the supra-branchial chamber.

Cell type B presented an enigma in that observations could not confirm its function, but they did suggest a plausible explanation. The majority of the secondary vesicles are non-granular and very sensitive to osmotic changes as confirmed by many broken vesicles. Therefore, the cell is actively enveloping excrement in a membrane and pinching it off in the form of secondary vesicles which suggests an excretory activity. Differential staining with Heidenhein's Azan Stain indicates that the material in the vacuoles is chemically basic.

Cell type C did not suggest a glandular function as in type B, but strongly indicated excretory activity. Fretter and Graham (1962) reported actual migration of blood cells into the nephridium of certain gastropods, and this, in part, is what was observed. Blood cells and cellular debris appeared as though they were being ingested by the cell. Whether the blood cells actually migrate or whether the excretory cell engulfs it by phagocytosis could not be definitely determined. There appeared to be various stages of breakdown of ingested material. Some of the ingested blood cells were still intact while some were broken down to the extent that it could not be determined whether this material was partially digested blood cells or some other kind of cellular debris. In later or more advanced stages of breakdown of the ingested material, the morphological characteristics of the normal columnar cell changed. It became more club shaped as though digested material were being concentrated at one end of the cell. In cases where there was a large amount of ingested material, a membrane could be observed surrounding a vacuole. Material in the vacuoles stained blue with Mallory's Triple Stain. In various cells of type C, secondary vesicles were being constricted and released into the pericardial cavity or the nephridial lumen. These vesicles contained granular material and were enclosed in a definite membrane. The change in staining properties of the ingested material as it is broken down indicates digestive activity by the excretory cell. Type B cells may also be functional in excretion, but results indicated that the nature of the material excreted is different from that excreted by type C. It was concluded that the type B cell has a more glandular-like function. Its resemblance to the familiar goblet cell of the vertebrate alimentary tract and also the observance of the presence of a similar type cell in the mantle prompted this conclusion.

SUMMARY

Histological examination of the epithelium of the nephridium and lining of the pericardial cavity of *Quadrula nodulata* (Rafinesque, 1820) revealed excretory activity on the cellular level. Results indicated that material is ingested by certain cells, enzymatically broken down, and excreted by way of constriction of secondary vesicles into the nephridial lumen or pericardial cavity. Three types of cells were observed to comprise the tissue of the nephridium

and lining of the pericardial cavity, and the nature of the activity observed in these cells suggests a mechanism of excretion on the cellular level.

REFERENCES

- Chandler, A. B., and R. A. Hand, 1961. Phagocytized Platelets: A Source of Lipids in Human Thrombi and Atherosclerotic Plaques. *Science* 134: 946-947.
- Duwe, A. E., 1948. The Microscopic Structure of the Kidney of Freshwater Clams in the Genus *Unio*. *Turtox News* 36 (7): 161-163, 3 figs.
- Fretter, V., and A. Graham, 1962. British Prosobranch Molluscs. Printed for the Ray Society. Adlard & Son Ltd., Bartholomew Press, Dorking, pp. v-xvi and 2-755, figs. 1-317.
- Galigher, A., and E. Kosloff, 1964. Essentials of Practical Microtechnique. Lea and Febiger, Philadelphia. 484 p.
- Gans, H., V. Subramanian, and B. H. Tan, 1969. Selective Phagocytosis: A New Concept in Protein Catabolism. *Science* 159: 107-109.
- Picken, L. E. R., 1937. The Mechanism of Urine Formation in Invertebrates. *Jour. Exp. Biol.* 14 (1): 20-34.

ANOTHER RECORD OF INSECT DISPERSAL OF AN ANCYLID SNAIL

By DR. JOSEPH ROSEWATER
Division of Mollusks
National Museum of Natural History
Washington, D. C. 20560

Two living specimens of *Lævapex fuscus* (C. B. Adams) (nomenclature of Basch, 1959 and 1963) were found attached to the outer surface of the elytra of a large (33 mm) dytiscid water beetle, *Cybister occidentalis* Aubé, taken in a light-trap at the Archbold Biological Station, Highlands County, Florida, March 7, 1967. The snails are catalogued under USNM 680346; specimen lengths are: 6.4 and 6.2 mm; widths: 4.3, 4.0 mm. According to Dr. S. W. Frost of The Pennsylvania State University, who sent the snails for identification, the light-trap was close to a drainage ditch, within a half mile of a swampy area, and about six miles from a small lake. As shown by Rees (1965) Ancyliidæ are the only fresh-water snails known to be transported by insects, and *L. fuscus* has been found previously on the elytra of *Dinutes* sp. in Wellesley, Massachusetts (Johnson, 1904). Although Rees

(ibid.) suggested that insects probably play a role only in the local dispersal of mollusks, a species could cross a continent or traverse narrow water barriers between islands by such "puddle-jumping." Such classical associations are utilized frequently in explaining the zoogeography and dispersal of species, and it is refreshing occasionally to witness one of these phenomena in action.

LITERATURE CITED

- Basch, P. F. 1959. The anatomy of *Lavapex fuscus*, a freshwater limpet (Gastropoda: Pulmonata). Miscellaneous Publications, Museum of Zoology, University of Michigan, no. 108, pp. 1-56, figs., tbl.
- . 1963. A review of the Recent freshwater limpet snails of North America. Bulletin of the Museum of Comparative Zoology Harvard, 129: no. 8, pp. 399-461, figs.
- Johnson, C. W. 1904. Ancyli adhering to water beetles. The Nautilus, 17: no. 10, p. 120.
- Rees, W. J. 1965. Presidential Address. The Aerial Dispersal of Mollusca. Proceedings of the Malacological Society of London, 36: part 5, pp. 269-282.

NOTES

CORBICULA IN BAJA CALIFORNIA—Two staff members of the Academy, Stanley C. Williams and V. F. Lee, collected a series of live *Corbicula manilensis* (Philippi) from an irrigation canal, one-half mile north of Cerro Prieto, just south of Mexicali, California, at an elevation of 100 feet. While abundant in the Salton Sea Basin, Colorado, it is believed that this is the first record for Baja California.—Ralph Olen Fox, Department of Invertebrate Zoology, California Academy of Sciences, San Francisco, California 94118.

WILLIAM H. WEEKS SHELL COLLECTION: New price lists of this famous collection, with full scientific data, are in preparation. Many new additions of fine and rare species are also included. To obtain free copies write:

GEORGE E. JACOBS, 853 Riverside Drive, New York 32, N. Y.

NEWS

A SYMPOSIUM ON THE INDIAN OCEAN AND ADJACENT SEAS will be held at Cochin, India, January 12-18, 1971. It is sponsored by the Marine Biological Association of India. Contributions of papers and participation are being requested. Registration forms and details may be obtained airmail from D. E. G. Silas, Marine Biol. Assoc., Jyothi Buildings, Gopalaprabhu Cross Road, Cochin 11, India.

D'ALTE ALDRIDGE WELCH—We regret to announce the death of our longtime friend and colleague on January 4, 1970, in Cleveland, Ohio. He was shot in a holdup attempt outside the Racquet Club on December 10, 1969. Dr. Welch published 10 papers on land mollusks, mainly on the Hawaiian *Achatinella*, in the Bulletin of the B. P. Bishop Museum, the Proceedings of the Academy of Natural Sciences of Philadelphia, and The Nautilus between 1929 and 1958.

He was born in New York City on April 9, 1907. His parents were Charles James and Elizabeth (Livingston) Welch. He received his Ph.D. from Johns Hopkins University in 1937. From 1942 to the time of his death he was a professor of biology at John Carroll University in Cleveland. He was a Research Fellow of the Department of Mollusks, Academy of Natural Sciences of Philadelphia. As a hobby, he studied American children's books printed prior to 1821, and published an extensive bibliography in the Proceedings of the American Antiquarian Society from 1963 to 1968. Dr. Welch is survived by his wife, Ann Frances (Goddard), and five children, of 2298 Coventry Road, Cleveland Heights, Ohio 44118—editors.

WORLD WIDE SPECIMEN SHELLS for sale. New 1970 Price List on request. "Illustrated Catalog of Popular Marginella Species" now available also, 117 species shown with full data and values listed with cover in color. Price \$2.00.

PHILLIP W. CLOVER
Apartado de Correos 22
Rota Cadiz, Spain

CONTENTS

Names of new genera, species, etc. in *italics*

Acella haldemani	68
Achatina fulica invades Florida	75
"Achatina", new publication	146
Acroloxus coloradensis	105
Alaska, marines of Port Moller Bay	65
Alaska, nonmarine mollusks	44
American Malacological Union	67
Ancylid dispersal by beetle	144
Anodontoides ferussacianus	114
Artica islandica, nomenclature	61
Articidae versus Cyprinidae	61
Ashmunella, longevity	109
<i>Aspella myrakeenae</i> Emerson and D'Attilio	88
Bermuda Biological Station	66
Bryce, George W., Jr.	105
Bursatella leachii pleii, biology	40
<i>Caecum condylum</i> D. R. Moore	26
<i>Caecum insularum</i> D. R. Moore	28
Cancellomorum	19
<i>Cancilla scrobiculata crosnieri</i> Cernohorsky	95
Colorado	105
Conocardium of the Paleozoic	77
Corbicula in Baja California	145
Coryphella verrucosa rufibranchialis	37
Cyclinella tenuis	113
<i>Cymatium boschi</i> Abbott and Lewis	86
Cyprinidae	61
Dates of the Nautilus issue	35
Davis, George M.	67
Donax fossor, variabilis	1
Doris verrucoa, biology	80
Galapagos Islands marines	19
Gallagher, J. L. and Harry W. Wells	22
Gilbertson, Lance H.	29
Grau, Gilbert (1906-1969)	66
Haas, Fritz (1886-1969)	117

Histology of <i>Quadrula nephridium</i>	139
Indian Ocean Symposium	146
<i>Laevapex fuscus</i> , dispersal by insect	144
Lamarck's unionid types illustrated	52
Land mollusks, indoor raising	136
<i>Latirus varai</i> Bullock	133
<i>Margaritifera falcata</i> , hermaphroditism	113
<i>Melanoides tuberculata</i> in Florida	72
————— in Texas	67
<i>Mercenaria</i> , with <i>Polydora</i> infestation	74
<i>Microvoluta joloensis</i> Cernohorsky	103
<i>Mitra pele</i> Cernohorsky	99
Mitridae, new species	95
<i>Monodenia</i> , longevity	109
Moore, Donald R.	26
Moore, George Mitchell (1906-1968)	No. 1, iii
Morris, Percy A. (1899-1969)	116
<i>Morum veleroae</i> , from Galapagos	19
North Carolina	40
Nudibranch feeding	37
<i>Odostomia cassandra</i> Bartsch, synonym	71
Oklahoma, <i>Polygyra</i>	120
<i>Oliva incrassata</i> forma <i>burchorum</i> Zeigler	15
<i>Oliva tremulina</i> forma <i>oldi</i> Zeigler	16
<i>Omalogyra atomus</i> from Maine	70
<i>Physa</i> of Rawson	36
<i>Physa striata</i> complex	73
<i>Plesiophysa pilsbryi</i>	73
<i>Polygyra dorfeuilliana</i> , variability	120
<i>Quadrula</i> , histology of <i>nephridium</i>	139
<i>Rangia cuneata</i> , range extension	22
<i>Sonorella</i> , longevity	109
<i>Sonorella odorata</i> in Arizona	29
<i>Succinea bakeri</i>	42
Unionidae, effect of change pH	69
Unionidae, Lamarck's types	52
Unionids of Alabama, Georgia and Florida	34
van der Riet, J. C. L. (1920-1969)	66
<i>Vexillum nodospiculum</i> Cernohorsky	101

Volutomitridae, new species 95

Welch, d'Alte Aldridge (1907-1970) 146

INDEX TO AUTHORS

Abbott, R. Tucker	75
Abbott, R. Tucker and Hal Lewis	86
Boss, Kenneth J. 61,	112
Branson, Branley A. 35,	120
Bullock, Robert C. 71, 76,	133
Carney, W. Patrick	136
Cernohorsky, Walter O.	95
Chanley, Paul	1
Clench, W. J. 72,	73
Corgan, James X. 65,	71
D'Attilio, Anthony (William K. Emerson)	88
Davis, John D.	74
Emerson, William K.	19
Emerson, William K. and Anthony D'Attilio	88
Fox, Ralph Olen	145
Franz, David R.	80
Franzen, Dorothea S. (P. R. Myers)	139
Harman, Willard N. 70,	115
Heard, William H.	113
Hubricht, Leslie	42
Johnson, Richard I. 34,	52
Johnson, Robert L. (Samuel J. Tuthill)	44
Kruczynski, W. L. and Hugh J. Porter	40
Lewis, Hal (R. Tucker Abbott)	86
Michelson, Edward H.	36
Morse, M. Patricia	37
Myers, Paul Robert and D. S. Franzen	139
Nicol, David	77
Porter, Hugh J. (W. L. Kruczynski)	40
Rosewater, Joseph	No. 1, iii, 144
Tuthill, Samuel J. and Robert L. Johnson	44
Walton, Munroe L.	109
Wells, Harry W. (John L. Gallagher)	22
Zeigler, R. F.	14

THE
NAUTILUS

THE PILSBRY QUARTERLY
DEVOTED TO THE INTERESTS OF CONCHOLOGISTS

EDITORS AND PUBLISHERS

HORACE BURRINGTON BAKER, 11 Chelten Road, Havertown, Pa.
(Emeritus Professor of Zoology, University of Pennsylvania)

R. TUCKER ABBOTT, duPont Chair of Malacology
Delaware Museum of Natural History, Greenville, Del. 19807

CHARLES B. WURTZ, *Biology Department*
La Salle College, Philadelphia, Pa. 19141



CONTENTS

Donax fossor: a summer range extension of *Donax variabilis*. By Paul Chanley 1

Two infrasubspecific forms in *Oliva*. By Rowland F. Ziegler.. 14

Galapagan records for *Morum veleroae* (Gastropoda: Tonnacea). by William K. Emerson 19

Northern range extension and winter mortality of *Rangia cuneata*. By John L. Gallagher and Harry W. Wells 22

A new *Caecum* from the tropical Western Atlantic.
By Donald R. Moore 26

Notes on the biology of the snail *Sonorella odorata* in Arizona. By Lance H. Gilbertson 29

Further Additions to the unionid fauna of the Gulf drainage of Alabama, Georgia and Florida.
By Richard I. Johnson 34

Notes and News 35 Publications received iv

\$4.25 per year (\$4.75 to Foreign Countries) \$1.25 a copy.

Mrs. Horace B. Baker, Business Manager
11 Chelten Road, Havertown, Pennsylvania 19083

Second-Class Postage paid at Spring House, Pa.

NAUTILUS:

A Quarterly Journal devoted to the study of Mollusks, edited and published by HORACE B. BAKER, CHARLES B. WURTZ and R. TUCKER ABBOTT.

AUTHORS PLEASE NOTE:

Matter for publication should be sent to the acting editor, Dr. R. Tucker Abbott, Delaware Museum of Natural History, Greenville, Delaware 19807. *Manuscripts should be typewritten and DOUBLE SPACED throughout, including titles, footnotes and bibliographies. Please give reprint order, if any.*

Please correct and return galley proof (submitted without manuscript) quickly. Changes from manuscript, as edited, may be disregarded.

Authors are charged for engraving blocks of plates and/or figures at cost. Minimum charge for each block is \$3.00.

REPRINTS are furnished at printer's rates. ORDERS SHOULD BE WRITTEN ON OR ATTACHED TO FIRST PAGE OF MANUSCRIPT. REPRINTS are shipped, with invoices, by PONY PRINTING, 4 Cloverdale Avenue, Upper Darby, Pennsylvania 19082. PURCHASE ORDERS, when required, and shipping instructions, *MUST* accompany original orders. Extra clerical or bookkeeping work because of delayed receipt of purchase orders will be charged for accordingly:

TEXT PAPER	2 pp.	4 pp.	8 pp.	12 pp.	16 pp.
First, 100 copies	3.40	6.35	13.25	18.70	23.95
Additional 100 .....	.65	1.40	4.30	5.50	6.70
PLATE PAPER					
First 100 copies	3.70	6.90	14.45	20.45	26.25
Additional 100 .....	.90	1.95	5.45	7.25	9.00

Prices subject to change without notice. Postage extra.

THE NAUTILUS is the official organ of the American Malacological Union. Information regarding membership in the Union may be obtained from Mrs. Margaret C. Tesky, Secretary, Route 2, Box 318, Marinette, Wisconsin 54143.

BACK ISSUES: Vols. 3-70, if available, can be obtained from KRAUS PERIODICALS, INC., 16 East 46th Street, New York, N. Y. 10017. Vols. 71 to date are available from the NAUTILUS, 11 Cheltenham Road, Havertown, Pennsylvania 19083, and vary in price.

EXCHANGE: Liguus information (have all references) for living specimens, especially from Fla. Keys and Cuba. DONALD J. HARVEY, 12700 Lake Ave., Lakewood, Ohio 44107.

MBL/WHOI LIBRARY



WH 17XT X

